erve
9
69P

THE PLANT DISEASE REPORTER

Issued by

THE PLANT DISEASE SURVEY, DIVISION OF MYCOLOGY AND DISEASE SURVEY
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
AGRICULTURAL RESEARCH ADMINISTRATION
UNITED STATES DEPARTMENT OF AGRICULTURE

SUPPLEMENT 155

VIRUSES, VIRUS DISEASES, AND SIMILAR MALADIES OF POTATOES, SOLANUM TUBEROSUM L.

LIBRARY
CURRENT SERIAL RECORD
☆ APR 21 1945 ☆
U. S. DEPARTMENT OF AGRICULTURE

April 1, 1945

The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

VIRUSES, VIRUS DISEASES, AND SIMILAR MALADIES OF POTATOES, SOLANUM TUBEROSUM L.

By Freeman Weiss[1], for the Sub-Committee on Potato Viruses, of the Committee on Virus Classification and Nomenclature, American Phytopathological Society

Plant Disease Reporter
Supplement 155 April 1, 1945

FOREWORD

This is the third section of the descriptive list of plant viruses that is being compiled under the auspices of this committee. Previous sections have been issued as Supplements 150 and 154 of the Plant Disease Reporter.

Aside from the scientific interest in the nomenclature of the viruses commonly associated with potatoes, there is a large economic interest in the diseases that these and other viruses cause in this crop. It therefore appears, in this instance at least, quite as important to systematize the identification and nomenclature of the virus diseases of potatoes as it is of their causal agents.

From the standpoint of the Plant Disease Survey the latter objective is primary, since the Survey records of incidence and economic effects apply to the diseases rather than to the etiologic agents. Because of the diversity of names applied to potato viroses in different countries and by different investigators, the problem of classifying such information in our plant disease index has been difficult. An attempt has therefore been made in Part II of the present list to assemble and classify the names of all virus and virus-like diseases of potatoes that are found in the readily accessible literature. This treatment comprises: (1) a statement of the cause of each disease in so far as the available information permits; (2) the designation of a common name under which, for the purpose of our records and indexes, information pertaining to each disease is filed; (3) the listing of names believed to be synonymous or equivalent that are used in this country and abroad.

The members of the Sub-Committee on Potato Viruses are: Donald Folsom of the Maine Agricultural Experiment Station, E. S. Schultz and Freeman Weiss of the U. S. Department of Agriculture. Grateful ackowledgment is here made of the assistance of these colleagues in organizing this material.

---

[1] Senior Pathologist, Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture.

CONTENTS

	Page
I. Viruses	84
A. Typical potato viruses	84
Mottle (Latent, X) Virus	84
Severe (Rugose) Mosaic or Leaf-drop Streak Virus	88
Di Vernon-Streak Virus	92
Veinal (Mild) Mosaic Virus	93
Paracrinkle Virus	99
Leaf-rolling Mosaic Virus	100
Aucuba Mosaic Virus	102
Tuber-Blotch Virus	103
Canada-Streak Virus	105
Leafroll Virus	106
Spindle-Tuber Virus	110
Unmottled Curly-Dwarf Virus	111
Witches'-broom Virus	112
Yellow-Dwarf Virus	114
B. Viruses infectious to potatoes that are typically identified with other plants	117
Alfalfa Mosaic (Potato Calico) Virus	117
Aster Yellows (Potato Purple-Top Wilt) Virus	118
Beet Curly-Top Virus	121
Cranberry False-Blossom Virus	121
Cucumber Mosaic Virus	121
Tobacco Etch Virus	123
Tobacco Mosaic Virus	123
Tobacco Ringspot Virus	124
Tomato Big-Bud Virus	125
Tomato Spotted-Wilt Virus	126
II. Virus and viruslike diseases	126

POTATO MOTTLE (LATENT) VIRUS

Technical name(s):

Solanum virus 1 K. M. Smith 1937

Marmor dubium vars. vulgare, annulus, obscurum, and flavum Holmes 1939 (These trinomials refer respectively to the mottle, ring-spot, masked, and yellow-mottle strains; there is no formally published binomial applicable to the virus as a whole.)

Synonyms: (1) General and mottle strains

Potato mosaic (virus) Orton 1914, in part
Potato mosaic disease (virus) Quanjer et al. 1919, in part
Potato interveinal (Duke of York) mosaic virus Quanjer 1923, in part
(Tobacco) mottle virus J. Johnson 1925
(Tobacco) spot-necrosis virus J. Johnson 1925, in part
Potato necrosis virus Schultz 1925
Mosaic B virus Fernow 1925
Tobacco virus 4 J. Johnson 1927, in part
Potato top necrosis virus Quanjer & Cortwijn Botjes 1929
Potato acronecrosis virus Quanjer 1931
Potato latent virus Burnett & Jones 1931
Potato (Arran Victory) mosaic virus K. M. Smith 1931
Potato virus X K. M. Smith 1931
Potato mottle virus Koch 1932
Potato simple mosaic virus Murphy & McKay 1932
Hy IV virus Hamilton 1932
Potato top necrosis X virus Salaman & Bawden 1932
Potato (President) interveinal mosaic virus Clinch & Loughnane 1933, in part
Potato masked mosaic virus Fernow 1933
Potato seedling streak virus Schultz et al. 1934
Potato latent mosaic virus Schultz et al. 1934
Potato virus 16 J. Johnson ex K. M. Smith 1935
Potato mild mosaic virus Samuel 1943, in I.M.I List 1944

(2) Ring-spot strain

(Tobacco) ring-spot virus J. Johnson 1925
Tobacco ring-spot virus J. Johnson 1927 (also K. M. Smith 1929; not Tobacco ring-spot virus Fromme et al. 1927)
Tobacco virus 5 J. Johnson 1927
Healthy potato virus Valleau & E. M. Johnson 1930
Potato virulent latent virus Burnett & Jones 1931
Potato ring-spot virus Koch 1933
Potato ring mosaic virus Köhler 1935
Potato mesomosaic virus Murphy 1935, in part
Potato foliar mottle (punctate necrosis) virus Larson 1943, 1944**

(3) President-streak strain

(Potato) President streak virus Murphy 1927, fide K. M. Smith 1937
(Potato) British Queen streak virus Schultz & Raleigh 1933
Potato foliar necrosis virus Bawden 1934

** Larson, R. H. Phytopath. 33: 1116. 1943; 34: 1006. 1944

Potato virus D Bawden 1934
Potato virus XD Salaman 1938
Solanum virus 6 K. M. Smith 1937

(4) Up-to-Date streak strain

(Potato) Up-to-Date streak virus Murphy 1926, fide K. M. Smith 1937
Potato streak A virus Salaman 1930, in part
Potato top necrosis A virus Salaman & Bawden 1932, in part
Potato virus B Bawden ex K. M. Smith 1933
Potato virus X (B) Murphy 1935
Solanum virus 4 K. M. Smith 1937
Potato virus Xu Köhler 1938

(5) American interveinal mosaic strain

Potato super-mild mosaic virus Young & Morris 1930
Potato interveinal mosaic virus McKay & Dykstra 1932
Green Mountain interveinal mosaic virus Folsom & Bonde 1936

(6) Yellow-mottle strain

Potato yellow-mottle virus Putnam 1937

(7) Aucklander Short-top strain

Aucklander Short-top virus Chamberlain 1941

(8) Miscellaneous strains

Numerous virus strains, mostly representing natural collections, or sometimes obtained by segregation of aberrant types (mutations -- Salaman 1938) from such collections, have been shown by property studies and host-reaction tests to belong to the mottle group of viruses. Present information does not suffice to establish the interrelationships of these strains or to determine whether they differ as much as the better-known "field" strains, which may actually be mixtures of "pure" strains, listed above. These strains have received various designations, as follows:

Strains XH, XG, XL, XD (foliar necrosis virus), XS, XN (interveinal necrosis virus), Salaman 1933, 1938
(in order of increasing severity of symptoms induced in potato and other suscepts)
Strains X-1 (Duke of York), X-2 (Gustav Adolf), X-3 (Kuckuck), and X-4 (Erdgold), Böhme 1933
Faint, medium, severe, and virulent strains (according to reaction of Datura), Schultz & Raleigh 1936
Strains XE and XN Köhler 1939
(XE inactivated at 75°C, XN at 68°; each group composed of numerous minor groups previously given separate symbols by this author)

There appears to be a continuous series of variant forms of this virus differing in the intensity of symptoms they evoke; these differences are usually but not invariably correlated in different hosts; they are best expressed in tobacco, tomato, Datura, and Hyoscyamus.

Names of disease: Mottle (simple or mild mosaic), Denmark, England, Germany, Sweden; mosaic, Holland; latent mosaic, U. S. In Europe these names usually refer to viroses caused by mottle viruses alone; in the U. S. these viruses, when present alone, are nearly or completely masked in most commercial varieties.

Geographical distribution: Worldwide. Commercial stocks of many potato varieties are nearly or quite universally infected, though commonly regarded as healthy.

Host range:

SOLANACEAE -- *Solanum tuberosum L.[1]

Atropa belladonna L., Browallia speciosa Hook., Capsicum frutescens L. (C. annuum L.), Datura meteloides Dunal, D. stramonium L. (D. inermis Jacq.), D. tatula L., Hyoscyamus niger L., Lycium barbarum L., Lycopersicon esculentum Mill., L. pimpinellifolium Mill., Nicandra physalodes (L.) Gaertn., Nicotiana alata Link & Otto, N. angustifolia [? Mill., -- form of N. tabacum], N. fragrans Hook., N. glutinosa L., N. langsdorfii Weinm., N. longiflora Cav., N. rustica L., N. sylvestris Speg., N. tabacum L., Petunia hybrida Vilm., (P. nyctaginiflora Juss.) = P. axillaris BSP., P. violacea Lindl., Physalis alkekengi L., P. pubescens L., (Salpiglossis variabilis Hort.) = S. sinuata Ruiz & Pav., Solanum dulcamara L., S. melongena L., (S. miniatum Bernh.) = S. villosum Willd., S. nigrum L., S. nodiflorum Jacq.

AMARANTHACEAE -- Amaranthus retroflexus L. (local necrosis)

CHENOPODIACEAE -- Beta vulgaris L. (red beet, sugar beet)

LEGUMINOSAE -- Vicia faba L.

RANUNCULACEAE -- ?Paeonia sp.

SCROPHULARIACEAE -- Digitalis lanata Ehrh. (local necrosis)

Symptoms: In different potato varieties, depending also on the strain of virus, symptom expression may be practically nil or consist only of a faint, transient, interveinal mottle, which is systemic and detectable only under optimum environmental conditions, or there may be nonsystemic necrotic spotting of the foliage, or severe top necrosis which is often systemic, involving tuber buds (eyes) as well as shoots. For practical purposes vars. showing more or less masked mottling can be classed as tolerant or carriers, but those reacting

---

1 * = natural infection

with top-necrosis are "field-immune" since infected plants are self-eliminating [Cockerham 1943].

In Datura stramonium the symptoms vary from invisible to a mild light- or dark-green mottle, or a conspicuous ring spot, especially on the middle leaves, followed by systemic mottling; severe strains induce large necrotic spots or more or less general necrosis. Tobacco plants react with either a diffuse mottle or with numerous, fine chlorotic rings. In tomato the effects vary from a mild, transient mottle to chlorotic and necrotic spotting; the yellow-mottle strain is characterized in this host by yellow vein-clearing, necrosis of young leaves, and later a systemic, yellow mottle. Pepper plants (Capsicum frutescens) react to even the weakest strains with necrotic spotting and to the more virulent strains with systemic necrosis. Intracellular bodies of the granular, vacuolate type are usually formed in association with all strains, especially those that induce a bright yellow mosaic in tobacco, and they occur in potato, tobacco, tomato and Datura. They are found mostly in the palisade and spongy parenchyma, and can be removed from the cells and even sectioned without dissolution by micro-manipulation [Bawden & Sheffield].

Means of transmission: By expressed juice readily between tolerant vars. of potatoes and from potatoes to other plants and also reciprocally. Transmission to intolerant vars. is usually effected only by grafting, either of stems or tubers. Not by any of the potato-infesting aphids nor by any other insect so far as known, though flower-infesting thrips have been suspected [Smith 1937] and dismissed as improbable [Cockerham 1937]. The nearly universal occurrence of mottle viruses in certain potato vars. is attributed to spread by contact of foliage in the field and of cut tubers used for "seed". Not transmitted by true seed.

Properties: Filterable in clarified sap through Pasteur-Chamberland L1, L3, and L5 candles, and through gradocol membranes of 175 mμ av. pore diameter. Estimates of particle size based on filtration methods vary from 45 to 450 mμ [Bawden 1943]. Dilution end-point 1:3,000 to 1:100,000, depending on strain, the necrotic strains being more resistant [Salaman 1938]. The yellow-mottle strain survives dilution at 1:1,000,000 [Putnam 1937]. Longevity in unclarified juice at room temp. 4 to 5 months, varying with the strain [Salaman 1938]. Thermal inactivation at 70° C for strain Xn (necrotic strain) and 68° C for 5 other strains [Salaman 1938, Bawden & Sheffield 1944]. Köhler (1939) found 1 strain surviving up to 75° C, others only to 68°. T. d. p. of yellow-mottle strain, 73° C [Putnam]. Although the virus is inactivated in extracted juice by drying, it can survive in dried plant tissue for some time -- 286 days in tobacco, 263 days in potato, and much longer, up to several years, when in combination with tobacco mosaic virus [Burnett 1934]. Sedimentation constant, Sw, 20°, = 113 to 131 X 10^{-13} sec.$^{-1}$ dynes^{-1}; mol. wt. determination from S, and based on assumed rod-shaped particles of dimensions 9.8 X 430 mμ, 26 X 10^{6} [Loring, 1938]. Dilute solutions show anisotropy of flow. Concentrated solutions are birefringent. Isoelectric point near pH 4; stable in pH range 4 to 9.5. A number of other properties, especially of the ringspot strain, have been determined and are reviewed by Bawden (1943).

Immunological and serological relationships: Inoculation of Datura, tobacco, Nicotiana glutinosa, and potatoes with XG or XH (non-necrotic) strains protected them against any of the severe strains XD, XL, XN, XS [Salaman 1938]; in general weak strains of mottle virus show this effect against stronger strains but no protection is conferred against viruses of the A or Y groups. However, Dennis (1939) found no reciprocal protective effect between Up-to-Date streak (B) virus and any tested strain of X virus.

Serologically the mottle virus group is unrelated to potato virus groups A or Y; likewise to tobacco mosaic, tobacco ring spot, cucumber mosaic, and other viruses. The various strains react in a similar manner serologically, but the potato mottle and potato ring-spot strains can be distinguished by precipitin reactions through employment of a special technique [Chester 1936].

Remarks:

Various workers have reported an increase in virulence of the mottle virus for potatoes as a result of successive passages through tobacco [Johnson 1925, Smith 1931]. This has also been interpreted as resulting from the differential multiplication of strains in an initial mixture such as ordinarily occurs in nature [Bald & White 1942]. Salaman (1938) converted severe strains to weaker ones by passage through uncongenial hosts such as beets and broadbeans, or by mixing infected tobacco juice with beet juice.

Resistance to mottle virus has been demonstrated in a number of potato varieties; in USDA seedling 41956 this resistance is absolute, no virus of this group, including virus B, being able to multiply in this clone. By introducing the 2 viruses B and X into graft unions with this stock Dykstra (1939) and Dennis (1939) believed that their separation could be effected, the former passing through alone, but Clinch (1942) found the virus content unchanged after such passage. According to Bawden and Sheffield (1944), although neither B nor any other tested strain of X virus multiplies in this variety, the virus may pass through it from an infected scion and be transferred to other susceptible plants.

Literature:

See list following VEINAL MOSAIC VIRUS.

POTATO SEVERE (RUGOSE) MOSAIC VIRUS

Technical name(s):

Solanum virus 2 K. M. Smith 1937
Marmor cucumeris var. upsilon Holmes 1939
Murialba venataenia (var.) Valleau 1940

Synonyms (including the several identified strains):

Potato streak (virus) Orton 1913, 1920, in part
(Distinct from the tuber disease previously named streak (= spraing) by Horne in England)
Potato curly dwarf (virus) Orton 1914, in part
Potato curly dwarf (virus), restricted sense, Appel 1915

Potato crinkle (virus) Murphy 1921, Quanjer 1923, in part
(See note on this name under veinal mosaic virus)
Potato leaf-drop (virus) Murphy 1921
Potato mosaic dwarf (virus) Schultz & Folsom 1922, in part
Potato russet dwarf (virus) Hungerford 1922
Potato stipple streak (virus) Atanasoff 1922
Potato leaf-drop streak virus Quanjer 1923
Potato rugose mosaic virus Schultz & Folsom 1923, in part
(Tobacco) spot necrosis virus J. Johnson 1925, in part
Tobacco virus 4 J. Johnson 1927, in part
Tobacco vein-margin virus Valleau & E. M. Johnson 1928
Tobacco (and potato) veinbanding virus Valleau & E. M. Johnson 1930
Acropetal necrosis virus Quanjer 1931
Potato virus Y K. M. Smith 1931
Hy. II virus Hamilton 1932
Potato viruses Yr and G.A. Köhler 1933
? Potato bigarrure virus Verplancke 1934
Potato virus 20 J. Johnson ex K. M. Smith 1935
Potato severe mosaic Samuel 1943, in I. M. H. List 1944

Name(s) of disease:
Severe mosaic, rugose mosaic, stipple streak, leaf-drop streak. (These are not synonymous but include strain differences of the virus and varietal differences in the host).

Geographical distribution: Probably worldwide; definitely identified in all potato districts of Europe and N. America, especially in the southern and intermediate zones, infrequent in northern zones (correlated with prevalence of aphids); also reported in S. America (Brasil, Peru); Africa (Kenya, Rhodesia); China, Australia, and New Zealand.

Host range:

SOLANACEAE -- *Solanum tuberosum L., *Nicotiana tabacum L.

Capsicum frutescens L., Hyoscyamus niger L., Lycium barbarum L., Lycopersicon esculentum Mill., L. pimpinellifolium Mill., Nicandra physalodes (L.) Gaertn., Nicotiana alata Link & Otto, N. fragrans Hook., N. glutinosa L., N. longiflora Cav., N. rustica L., N. sylvestris Speg., Petunia hybrida Vilm., Physalis pubescens L., Salpiglossis sinuata Ruiz & Pav., Schizanthus retusus Hook. (symptomless), Solanum dulcamara L., S. nigrum L., S. nodiflorum Jacq.

Datura stramonium L. is immune to infection by this virus, this constituting a distinctive test and means of separating viruses of this group from the mottle (X) group.

CONVOLULACEAE -- Convolvulus arvensis L.

CRUCIFERAE -- The Y strain is reported to have been found without symptoms in various Brassica spp. including Brussel sprouts, cabbage, kale, and turnips [Salaman & Wortley].

LEGUMINOSAE -- Trifolium pratense L., Vigna sinensis (Torner) Savi ex Hassk.

Symptoms: In different potato vars. symptoms vary from complete masking (in the Dutch var. Zeeland Blue), through diffuse mottling with or without leaf distortion, to more or less severe veinal or sometimes interveinal necrosis. In plants grown from infected tubers the symptoms are accentuated, with marked leaf distortion, veinal necrosis, brittleness of stems and petioles (stipple streak); or by leaf and stem necrosis together with partial abscission of basal leaves, which often remain attached by their vascular bundles (leaf-drop streak). The typical syndrome of rugose mosaic usually results from the additional presence of mottle (X) virus, or may be due to Y virus alone [Quanjer 1935]; likewise, acropetal necrosis and leaf-drop may result from Y virus alone [Murphy 1936]. The progression of necrotic symptoms is characteristically upward except for the apical leaf necrosis resulting from initial infection. Viruses of this group also may occur in combination with veinal mosaic (A) virus, with intensification of the ordinary symptoms of each, since there is no reciprocal protection. Symptom expression does not decline at high temperatures (22-30°C).

In tobacco the viruses of this group induce a characteristic veinal chlorosis banded by darker green, to which the name "veinbanding" was given [Valleau & E. M. Johnson]; followed by a general interveinal chlorosis or yellowing. There are typically no necrotic effects in this host, though certain strains, as 2A of Köhler, and a variant described by Smith and Dennis (1940) are exceptions in this respect.

Virus Y also induces strong veinbanding in Nicotiana alata and N. glutinosa, whereas virus A causes no symptoms. [Köhler 1939, 1940; Stelzner & Schwalb 1943].

In Lycium barbarum, virus Y induces brown, circular lesions without systemic infection whereas other potato viruses (A, F, G, X) and cucumber mosaic virus are symptomless or non-infective [Dennis 1938].

The occurrence of virus Y in masked form in Brassica spp., Convolvulus arvensis and Trifolium pratense was reported by Salaman & Wortley, but Bawden & Sheffield were unable to infect cabbage or Brussels sprouts. In cowpea, the veinbanding strain induces reddish, necrotic, local lesions.

A few small intracellular bodies are produced in potato and tobacco plants infected by Y virus and related viruses; they are readily distinguishable from the characteristic inclusion bodies associated with X virus infection of various hosts. [Bawden and Sheffield 1944].

Means of transmission: By juice transfer (leaf-rubbing) [Schultz & Folsom 1923 and 1925, J. Johnson 1925, Valleau & E. M. Johnson 1930], facilitated by the use of carborundum [Dykstra 1939]; not transmissible by the needle-prick method [Smith 1931] and therefore separable from the needle-transmitted X virus. By stem and tuber grafts [Murphy & McKay 1926]. By the aphids Aphis rhamni Boy., Macrosiphum solanifolii (Ashm.), Myzus circumflexus (Buckt.), M. ornatus Laing, and M. persicae (Sulz.), especially the latter [Smith 1929, Koch 1933,

Dykstra 1939, Watson & Roberts 1939, Kassanis 1942]. Belongs to the non-persistent group of viruses which become inactivated during insect feeding; the efficiency of the insect as a vector is increased by a preliminary period of fasting [Watson & Roberts]. Apparently by seed, as acropetal necrosis, in a small proportion of cases [Reddick 1934].

Properties: Y and veinbanding strains - Do not pass filter candles but pass with difficulty through gradocol membranes of 600-700 mμ av. pore diameter [Bawden 1943]. Dilution tolerance 1:100 to 1:1,000 [Smith, Dykstra], 1:5,000 [Koch & Johnson]. Longevity in vitro 24-36 hr. [Smith], 72 hr. at 15° C [Dykstra], 4 days [Koch & Johnson], 1 week [Bawden & Sheffield]. Thermal inactivation 52° [Smith], 56° [Dykstra], 57° [Bawden & Sheffield], 58° [Köhler], 58° [Koch & Johnson]. pH tolerance (24 hr.) 4.2-8.5 [Dykstra]. Survives in drying potato or tobacco tissue up to 50 days [Burnett 1932].

Rugose mosaic strain - Lower dilution tolerance (1:10), higher thermal death point (60-65°) [Folsom & Bonde 1937].

Stipple streak strain - Slightly greater dilution tolerance (1:1000 +), lower thermal death point (54° C), narrower pH tolerance (4.7-8.5) [Dykstra 1939].

Aberrant types - A strain believed to belong to the Y group was reported by Smith & Dennis (1940) to withstand aging for 27 days at room temp. and to be filterable through membranes of 215 mμ pore diameter.

Immunological and serological relationships: Weak strains of the Y virus group protect plants (potato, tobacco) into which they are introduced against the manifestation of severe symptoms ordinarily induced by more virulent strains [Salaman 1937, Köhler 1937]. Attenuated strains of virus Y have been produced by cultivation on tobacco roots [Salaman 1937]. No reciprocal protective influence is exerted by strains of this virus against strains of veinal mosaic (A) virus [Bawden & Sheffield] but others have found some strains difficult to classify because of the general similarity between the 2 groups. According to Chester (1937) the Y, stipple-streak, and veinbanding viruses are serologically indistinguishable, and all react strongly with cucumber mosaic virus but Bawden & Sheffield found no such relation. Antisera (precipitins) for the Y group were found to react equally to viruses Y and A [Hansen 1937], but others [Köhler 1940, Stapp 1942, Bawden & Sheffield 1944] found that no precipitation of virus Y antiserum occurred with virus A, or vice versa. No serological reactions occur between viruses of the Y and X groups [Chester, Hansen].

Remarks:

The existence in nature not only of strains (Y, veinbanding, and stipple-streak) together constituting the severe mosaic group of potato viruses, but also of a number of substrains differing in reactions induced in different hosts has been noted [Böhme 1933, Köhler 1934, Salaman 1937]. With the exception of the strain identified as Di Vernon streak (see following) and the aberrant form described by Smith & Dennis, these strains are similar in properties and most host reactions; however, intermediate forms between this group and virus A occur and have presented difficulties

in classification [Köhler 1939, Murphy and Loughnane 1936]. These 2 groups are apparently related but differ enough for specific distinction. The postulated relationship of this group to the cucumber mosaic virus on serological grounds only, is rendered doubtful by contradictory evidence in this respect as well as distinct differences in other respects [Loughnane & Murphy, Hansen, Dykstra 1939, Köhler 1940, Bawden & Sheffield].

Literature:
See list following VEINAL MOSAIC VIRUS.

DI VERNON-STREAK VIRUS

Technical name:
Solanum virus 5 K. M. Smith 1937

Synonyms:
(Potato) Di Vernon streak virus Salaman 1930
Potato streak B virus Salaman 1930
Potato top necrosis B virus Salaman & Bawden 1932
Potato virus C Bawden 1936

Geographical distribution: Eire, England, Scotland, ? Netherlands, Peru.

Host range:

SOLANACEAE -- *Solanum tuberosum L., Nicotiana tabacum L.

This virus is carried (together with the mottle virus) in masked form in the Di Vernon var.; it has also been found in several other British, and one Dutch, vars.

Symptoms: Causes top necrosis (necrotic spotting of foliage, streaking of stems and petioles) in intolerant vars. as Epicure, President and Up-to-Date, but only a mild transient mottle in Di Vernon, Arran Victory, and other tolerant vars. In the American vars. Burbank, Bliss Triumph, and Irish Cobbler, the initial reaction to inoculation (by grafting) is a severe top necrosis, but in the second generation from tubers only slight mottling or occasional necrotic spotting persists [Dykstra 1939]. In general, this virus causes top necrosis in vars. that react to virus Y with leaf-drop streak, and is systemic and masked in vars. in which virus Y induces a mosaic. It induces small intercellular bodies in systemically infected leaves similar to those associated with virus Y [Bawden & Sheffield].

Means of transmission: By stem grafts [Salaman 1930, Bawden 1932]; by extracted juice with aid of carborundum [Cockerham 1943; Bawden & Sheffield], with production of local lesions on potato vars. that react with top necrosis to graft-transmission. It is also transmissible by sap inoculation to tobacco [Dykstra 1939; Bawden & Sheffield 1944]. It was not transmitted between potatoes by Myzus persicae under the same conditions in which 100 percent transmission of virus Y occurred [Bawden & Sheffield].

Properties: Thermal inactivation at 57° C; longevity in vitro 1 week [Bawden & Sheffield].

Remarks:

This virus is regarded by British workers as a strain of or related to virus Y [Cockerham 1943, Bawden & Sheffield 1944]. It differs from Y in causing either acronecrosis or a mild form of mosaic, but not acropetal necrosis, in all tested potato vars., and is less readily transmissible, at least by aphids. In Arran Victory potatoes containing virus A it causes a chlorotic crinkle. Dykstra (1939) observed no protective effect in potatoes against virus Y, but reciprocal protection between these 2 viruses in tobacco was reported by Bawden & Sheffield.

Literature:

See list following VEINAL MOSAIC VIRUS

POTATO VEINAL (CRINKLE, MILD) MOSAIC VIRUS

Technical name(s):

Solanum virus 3 K. M. Smith 1937
Marmor solani Holmes 1939

Synonyms:

Potato mosaic (virus) Orton 1914, in part
Potato mosaic disease (virus) Quanjer et al. 1919, in part
Potato mosaic virus Schultz, Folsom et al. 1919, in part
Potato mild mosaic virus Schultz & Folsom 1923, in part
Potato crinkle mosaic virus Schultz & Folsom 1923, in part[2]
Potato common mosaic Quanjer 1923
Potato crinkle virus K. M. Smith 1930, in part
Potato crinkle A virus Salaman 1930, in part
Potato mild mosaic virus Quanjer 1931
Potato intermediate mosaic virus Quanjer 1931
? Potato z virus Salaman 1932
Potato merocrinkle virus Murphy 1935
Potato simple mosaic, super-mild mosaic virus (in var. Bravo) Quanjer, fide Murphy 1935
Potato virus A Murphy & McKay 1932
Potato veinal mosaic virus Murphy 1936
Potato virus P Köhler 1937

Name of disease: Mild mosaic, United States; common mosaic, Holland; veinal mosaic, England

---

[2] The disease described as crinkle by Murphy in eastern Canada in 1921, and also in Europe by Quanjer in 1921, appears to have been the disease later described as rugose mosaic (a complex virosis) in Maine by Schultz & Folsom, and differs from their crinkle mosaic [J. Johnson 1929]. British usage has accepted the name crinkle for a disease caused by the joint action of the mottle and veinal mosaic viruses, with symptoms different from those of either virus by itself; it corresponds to the field disease known as mild mosaic in the United States.

Geographical distribution: Probably worldwide. In North America is coextensive with potato culture, occurring more frequently in field culture than the severe types of mosaic (rugose and streak). In Europe has been identified in the British Isles, France, Germany, Holland and Italy; elsewhere reported in Australia, New Zealand, Japan, Kenya, and Rhodesia.

Host range:

SOLANACEAE -- *Solanum tuberosum L.

Datura stramonium L. (by grafting only), Nicotiana alata Link & Otto (symptomless), N. fragrans Hook., N. longiflora Cav., N. sylvestris Speg., N. tabacum L.

Certain varieties of potatoes are immune from at least some strains of this virus (Irish Cobbler and Katahdin to mild mosaic); several carry it with scarcely evident symptoms; others are hypersensitive.

Symptoms: In tolerant potato vars., e.g. Green Mountain, this virus, freed from latent virus, causes a faint mottle involving both veinal and interveinal tissues [Dykstra 1939]. Together with the latent virus it induces a strong mottle and more or less ruffling or crinkling depending on the strains of both viruses that are involved [Schultz & Raleigh 1936]. The most common manifestation of this virus complex in American commercial varieties is mild mosaic; the less prevalent crinkle mosaic is similar but leaf distortion is more marked. The strains of veinal mosaic virus occurring in European crinkle cause nearly identical symptoms. Symptom expression declines at high temperatures (+22°C). In intolerant vars., as British Queen and Up-to-Date, it causes a severe, usually fatal, top necrosis in the aerial parts, together with both superficial and internal necrosis of the tubers. Together with severe mosaic (Y) virus it causes a pronounced yellow mosaic in certain potato vars. It also accentuates the foliage symptoms of the aucuba mosaic and tuber blotch viruses, and facilitates their transmission by aphids [Clinch et al. 1936]. No intracellular bodies were found in potato or tobacco plants solely infected with this virus [Bawden & Sheffield 1944]. In tobacco it causes vein clearing and green banding [Bawden], a faint mottle [Dykstra], small yellow patches along the veins [Dykstra].

Means of transmission: By juice inoculations with aid of carborundum, both between potatoes and to or from tobacco. By tuber and stem grafts. By the aphids Aphis rhamni Boy., Macrosiphum solani (Kalt.), M. solanifolii (Ashm.), Myzus persicae (Sulz.), and M. circumflexus (Buckt.) [Schultz & Folsom 1923, Dykstra 1938].

Properties: Mild mosaic strain -- Dilution tolerance 1:100; longevity in vitro 2-4 hrs.; thermal inactivation 40-45° C. Crinkle mosaic strain -- 1:10, 24-45 hrs., and 43-45° resp. [J. Johnson 1929]

Immunological and serological relations: Potato viruses X and A retained their individual characteristics unchanged when present together, and

did not show reciprocal protective effects in potatoes [Hanson 1931]. Tobacco infected with a strain of virus A exhibited typical symptoms when inoculated with virus Y [Köhler 1937]. Potato mild mosaic virus was placed in a separate group from the veinbanding virus on the basis of precipitin tests by Chester (1937), but viruses Y and A reacted similarly to anti-Y serum according to Hanson (1937). By the use of different methods of preparation, anti-sera reacting specifically for viruses A and Y (and also distinct from X) were obtained [Köhler 1940, Stapp 1942, Bawden & Sheffield 1944].

Remarks:

Aside from the marked differences in symptoms induced in commercial potato vars. carrying latent (mottle) viruses in the United States, e.g. mild mosaic or crinkle mosaic by viruses of the present group contrasted with rugose mosaic or streak by viruses of the veinbanding group, there are other host reactions indicating their specific distinction. Nicotiana alata, N. glutinosa, Lycium barbarum, and Lycopersicon pimpinellifolium react to veinbanding or Y virus with either necrotic spotting or veinbanding, but are immune from virus A. On the other hand Datura stramonium, which is immune from virus Y, accepts virus A when inoculated by grafting.

Literature:**

Appel, O. Leaf roll diseases of the potato. Phytopath. 5: 139-148. 1915.

Atanasoff, D. Stipple-streak disease of potato. Meded. Landbouwhoogesch. Wageningen 24(5): 1-32. 1922.

Bald, J. G. and N. H. White. Potato virus X: the average severity of strain mixtures in three varieties of potato. Jour. Counc. Sci. & Industr. Res. Australia 15: 300-306. 1942.

Bawden, F. C. A study on the histological changes resulting from certain virus infections of the potato. Proc. Roy. Soc. London, Ser. B. 111: 74-85. 1932.

_____ Studies on a virus causing foliar necrosis of the potato. Proc. Roy. Soc. London. Ser. B. 116: 375-395. 1934.

_____ The viruses causing top necrosis (acronecrosis) of the potato. Ann. Appl. Biol. 23: 487-497. 1936.

_____ Plant viruses and virus diseases. 2nd. ed. Chronica Botanica Co., Waltham, Mass. 1943.

_____ & F. M. L. Sheffield. The relationship of some viruses causing necrotic diseases of the potato. Ann. of Appl. Biol. 31: 33-40. 1944.

Böhme, R. W. Vergleichende Untersuchungen mit Stämmen des "X" - und "Y" - Virus. Phytopath. Zeitschr. 6: 517-534. 1933.

Burnett, Grover. The longevity of the latent and veinbanding viruses of potato in dried plant tissue. Phytopath. 24: 215-227. 1934.

_____, and Leon K. Jones. The effect of certain potato and tobacco viruses on tomato plants. Washington Agric. Exp. Sta. Bull. 254. 1-37. 1931.

Chamberlain, E. E. A masked virus of Aucklander Short-top potatoes. New Zealand Jour. Sci. & Tech., A, 22: 57-71. 1940.

** See also footnote, page 84

Chester, K. Starr. Separation and analysis of virus strains by means of precipitin tests. Phytopath. 26: 778-785. 1936.

_____ Serological studies of plant viruses. Phytopath. 27: 903-912. 1937.

Clinch, Phyllis E. M. The identity of the top-necrosis virus in Up-to-Date potato. Sci. Proc. Roy. Dublin Soc. N. S. 23: 18-34. 1942.

_____ & J. B. Loughnane. A study of the crinkle disease of potatoes and of its constituent or associated viruses. Sci. Proc. Roy. Dublin Soc. N. S. 20: 567-596. 1933.

_____, _____, and P. A. Murphy. A study of the aucuba or yellow mosaics of potato. Sci. Proc. Roy. Dublin Soc. N. S. 21: 431-448. 1936.

Cockerham, G. Potato flowers and dissemination of potato viruses. Nature 140: 1100-1101. 1937.

_____ The reactions of potato varieties to viruses X, A, B, and C. Ann. Appl. Biol. 30: 338-344. 1943.

Dennis, R. W. G. A new test for potato virus Y. Nature 142: 154. 1938.

_____ Studies on Solanum 4. Phytopath. 29: 168-177. 1939.

Dykstra, T. P. Comparative studies of some European and American potato viruses. Phytopath. 26: 597-606. 1936.

_____ A study of viruses infecting European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 40-67. 1939.

_____ and W. C. Whitaker. Experiments on the transmission of potato viruses by vectors. Jour. Agric. Res. 57: 319-334. 1938.

Fernow, Karl H. Interspecific transmission of mosaic diseases of plants. Cornell University Agric. Exp. Sta. Mem. 96. 1-34. 1925.

_____ A partially masked mosaic virus of potatoes. Amer. Potato Jour. 10: 235-245. 1933.

Folsom, Donald & Reiner Bonde. Some properties of rugose mosaic and its components. Jour. Agric. Res. 55: 765-783. 1937.

Hamilton, Marion A. On three new virus diseases of Hyoscyamus niger. Ann. Appl. Biol. 19: 550-567. 1932.

Hansen, H. P. Studier over Kartoffelvirøser i Danmark. Tidsskr. Planteavl. 42: 641-681. 1937.

Holmes, Francis O. Handbook of phytopathogenic viruses. Burgess Publ. Co., Minneapolis, Minn. 1939.

Hungerford, C. W. Leaf roll, mosaic and certain other related diseases in Idaho. Phytopath. 12: 133-139. 1922.

Johnson, James. Transmission of viruses from apparently healthy potatoes. Wisconsin Agric. Exp. Sta. Res. Bull. 63. 1-12. 1925.

_____ The classification of plant viruses. Wisconsin Agric. Exp. Sta. Res. Bull. 76. 1-16. 1927.

_____ The classification of certain virus diseases of the potato. Wisconsin Agric. Exp. Sta. Res. Bull. 87. 1-24. 1929.

Kassanis, B. Transmission of potato virus Y by Aphis rhamni (Boyer). Ann. Appl. Biol. 29: 95. 1942.

Koch, K. L. The nature of potato rugose mosaic. Phytopath. 23: 319-342. 1933.

_____ and J. Johnson. A comparison of certain foreign and American potato viruses. Ann. Appl. Biol. 22: 37-54. 1935.

Köhler, E. Untersuchungen über die Viruskrankheiten der Kartoffel. I. Versuche mit Viren aus der Mosaikgruppe. Phytopath. Zeitschr. 5: 567-591. 1933.

_____ Untersuchungen über die Viruskrankheiten der Kartoffel. III. Weitere Versuche mit Viren aus der Mosaikgruppe. Phytopath. Zeitschr. 7: 1-30. 1934.

_____ Mischinfektionen mit verschiedensen Stämmen des Ringmosaikvirus (X-virus Gruppe) der Kartoffel. Angew. Bot. 17: 60-74. 1935.

_____ Zur Frage der Schutzimpfung bei den Veinbanding-Viren. Nachrbl. Deutsch. Pflanzsch. 17: 32-33. 1937.

_____ Ueber ein "Veinbanding-Virus" der Kartoffel. Phytopath. Zeitschr. 10: 17-29. 1937.

_____ Zur Differenzierung des A- and Y- virus in Infektionsversuch. Naturwiss. 27: 215. 1939.

_____ Weitere Studien über die Vira der Y-gruppe der Kartoffel. Phytopath. Zeitschr. 12: 450-489. 1940.

Loring, H. S. Properties of the latent mosaic virus protein. Jour. Biol. Chem. 126: 455-478. 1938.

Murphy, Paul A. Investigation of potato diseases. Canada Dept. Agric. Exp. Farms Bull. 44, 2nd ser. 1-86. 1921.

_____ Identity and spread of some potato viruses of the mosaic group. Proc. Sixth Intern. Bot. Congress, Amsterdam, 1935. II (abstracts): 198-199. 1935.

_____ Nature and control of potato virus diseases. Nature 138: 955. 1936.

_____ and Robert McKay. Methods for investigating the virus diseases of the potato, and some results obtained by their use. Sci. Proc. Roy. Dublin Soc. 18(N.S.): 169-184. 1926.

_____ _____ A comparison of some European and American virus diseases of the potato. Sci. Proc. Roy. Dublin Soc. 20(N.S.): 347-358. 1932.

_____ _____ The compound nature of crinkle, and its production by means of a mixture of viruses. Sci. Proc. Roy. Dublin Soc. 20(N.S.): 227-247. 1932.

_____ and J. B. Loughnane. A comparison of some Dutch and Irish potato mosaic viruses. Sci. Proc. Roy. Dublin Soc. 21 (N.S.): 419-430. 1936.

Orton, W. A. Leaf roll, curly leaf and other new potato diseases. Phytopath. 3: 69. 1913.

_____ Potato wilt, leaf-roll, and related diseases. U. S. Dept. Agric. Bull. 64. 1-48. 1914.

_____ Streak disease of potato. Phytopath. 10: 97-100. 1920.

Putnam, D. F. Comparative studies in potato virus diseases. Canad. Jour. Res., Sec C. 15: 87-107. 1937.

Quanjer, H. M. New work on leaf curl and allied diseases in Holland. Roy. Hort. Soc., London. Repot. Internat. Potato Conf. 1921. 127-145. 1922

_____ General remarks on potato diseases of the curl type. Rept. Intern. Conf. Phytopath. & Econ. Ent. Holland 1923. 23-28. 1923.

_____ The methods of classification of plant viruses, and an attempt to classify and name potato viroses. Phytopath. 21: 577-613. 1931.

_____ Classification of potato-viroses. Sixth Inter. Bot. Congr., Amsterdam, 1935, II (abstracts): 199-203. 1935

_____ , J. C. Dorst, M. D. Dijt, and A. W. van der Haar. De mozaiekziekte van de Solanaceeën hare verwantschap med de phloeemnecrose en hare beteekenis voor de aardappelcultuur. Meded. Landbouwhoogeschool 17. 1-74. 1919

_____ , and J. G. Oortwijn Botjes. Aardappelziekten van het "stippelstreep" -en "top necrose" type en het vraagstuk der latentie en physiologische specialisatie. Meded. Landbouwhoogeschool 33, 7. 1-44. 1929

Reddick, Donald. Seed transmission of potato virus diseases. Amer. Potato Jour. 13: 118-124. 1936

Salaman, R. N. Crinkle "A", an infectious disease of the potato. Proc. Roy. Soc. London, Ser. B, 106: 50-83. 1930.

_____ Virus diseases of the potato: streak. Nature 126: 241. 1930.

_____ The analysis and synthesis of some diseases of the mosaic type. The problem of carriers and auto-infection in the potato. Proc. Roy. Soc. London, Ser. B, 110: 186-224. 1932

_____ Acquired immunity against the "Y" potato virus. Nature 139: 924-925. 1937

_____ The potato virus "X": its strains and reactions. Philos. Trans. Roy. Soc. London, Ser. B, 229: 137-217. 1938

_____ , and F. C. Bawden. An analysis of some necrotic diseases of the potato. Proc. Roy. Soc. London, Ser. B, 111: 53-73. 1932

_____ , and W. R. S. Wortley. Potential hosts of potato viruses in garden and field. Nature 144: 1049-1050. 1939

Schultz, E. S, C. F. Clark, Reiner Bonde, W. P. Raleigh, and F. J. Stevenson. Resistance of potato to mosaic and other virus diseases. Phytopath. 24: 116-132. 1934

_____, and Donald Folsom. Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25: 43-118. 1923

_____, and _____ Infection and dissemination experiments with degeneration diseases of potatoes. Observations in 1923. Jour. Agric. Res. 30: 493-528. 1925

_____, and W. P. Raleigh. A new necrotic virus of potatoes. Phytopath. 23: 32. 1933

_____, and _____ Reaction of a Green Mountain potato seedling to composite infections of mild and crinkle mosaic and of different types of latent mosaic virus. Phytopath. 26: 107. 1936

Smith, K. M. Studies on potato virus diseases. IV. Further experiments with potato mosaic. Ann. Appl. Biol. 16: 1-33. 1929.

_____ Studies on potato virus diseases. VII. Some experiments with the virus of a potato crinkle with notes on interveinal mosaic. Ann. Appl. Biol. 17: 223-240. 1930.

_____ Composite nature of certain potato viruses of the mosaic group. Nature 127: 852-853. 1931.

_____ On the composite nature of certain potato virus diseases of the mosaic group as revealed by the use of plant indicators and selective methods of transmission. Proc. Roy. Soc. London, Ser. B, 109: 251-267. 1931.

_____ Plant virus diseases. P. Blakiston's Son & Co., Inc. Philadelphia, Pa. 1937.

_____ and R. W. G. Dennis. Some notes on a suspected variant of Solanum virus 2 (Potato virus Y). Ann. Appl. Biol. 27: 65-70. 1940.

Stapp, C. Serologischer Nachweis von X-, Y-, und A- Virus der Kartoffeln. Vorläufige Mitteilung. Zentralbl. Bakt., Abt. 2. 105: 127-128. 1942.

Stelzner, G. and H. Schwalb. Reaktion einer Reihe von Solanaceen auf Infektion mit A-, Y-, und X- Virus der Kartoffel unter Berücksichtigung ihrer Brauchbarkeit als Testpflanze. Phytopath. Zeitschr. 14: 497-511. 1943.

Valleau, W. D. Classification and nomenclature of tobacco viruses. Phytopath. 30: 820-830. 1940.

_____ and E. M. Johnson. Some virus diseases of tobacco in Kentucky. Phytopath. 18: 132-133. 1928.

_____ _____ The relation of some tobacco viruses to potato degeneration. Kentucky Agric. Exp. Sta. Bull. 309. 475-502. 1930.

Verplancke, G. Sur une forme nouvelle de la "bigarrure", maladie à virus filtrante de la pomme de terre. Bull. Soc. Roy. Bot. Belg., Ser. 2, 16: 107-121. 1934.

Watson, M. A. and F. M. Roberts. A comparative study of the transmission of Hyoscyamus virus 3, Potato virus Y, and Cucumber virus 1 by the vectors Myzus persicae (Sulz.), M. circumflexus (Buckton), and Macrosiphum gei (Koch). Proc. Roy. Soc., London, Ser. B, 127: 543-576. 1939.

Wiltshire, S. P. et al. Virus names used in the Review of Applied Mycology. (Mimeographed.) Imp. Myc. Inst. Kew, England. 1944.

POTATO PARACRINKLE VIRUS

Technical name(s):

Solanum virus 7 K. M. Smith 1937

Marmor angliae Holmes 1939

Synonyms:

Potato paracrinkle virus Salaman & Le Pelley 1930

Potato virus E Bawden in K. M. Smith 1933

(not potato virus E Dykstra 1939)

Name of disease: Paracrinkle

Geographical distribution: Great Britain, Hungary

Host range:

SOLANACEAE -- *Solanum tuberosum L.
Datura stramonium L., Lycopersicon esculentum Mill.

Symptoms: Masked in var. King Edward, in which it is present naturally, and in President; blotchy chlorosis, vein-clearing, ruffling, and rugosity in certain other vars.; "curly dwarf" in Arran Victory [Salaman & Le Pelley]. In American vars. of potato, the primary symptoms consisted of large mosaic-like blotches without rugosity, the secondary included necrotic spotting also. In tomato it caused filiform leaves [Dykstra]. In Datura, a diffuse mottle and yellow spots.

Means of transmission: By stem grafts; all attempts at juice transmission thus far have failed.

Properties: Not demonstrated.

Literature:

Dykstra, T. P. Comparative studies of some European and American potato viroses. Phytopath. 26: 597-606. 1936.

_____ A study of viruses infecting European and American varieties of potato, Solanum tuberosum. Phytopath. 29: 40-67. 1939

Gulyás, A. (The virus diseases of potato. Their importance in connection with degeneration and their control.) M. Kir. Gazdas. Akad. Mun. I, 3: 1-63. 1938. In Hungarian, with English and German summaries.

Salaman, R. N., and R. H. Le Pelley. Para-crinkle, a potato disease of the virus group. Proc. Roy. Soc. London Ser. B, 106: 140-175. 1930.

Smith, K. M. The present status of plant virus research. Biol. Rev. 8: 136-179. 1933.

POTATO LEAF-ROLLING MOSAIC VIRUS

Technical name(s):

Solanum virus 11 K. M. Smith 1937

Synonyms:

Potato leaf-rolling mosaic Schultz & Folsom 1923
Potato leaf-rolling mosaic virus Folsom 1926
Potato virus 7 Johnson ex K. M. Smith 1935
Potato virus E Dykstra 1939
(not potato virus E Bawden in K. M. Smith 1933)
? Potato rolling mosaic virus Köhler 1935
? Potato virus Z Köhler 1938, not Salaman 1932
? Potato virus K Köhler 1941

Name of disease: Leaf-rolling mosaic

Geographical distribution: U. S. (Me., Mont., N. Dak., Oreg., Utah, Wis.); ? Germany.

Host range:

SOLANACEAE — *Solanum tuberosum L.

Symptoms: (Primary), slight dwarfing, diffuse mottling, wrinkling, slight ruffling and rolling of upper leaves only; (secondary), similar effects becoming general; the leaves remain flaccid.

Means of transmission: By sap, by grafting, and by the aphids Macrosiphum solanifolii (Ashm.), M. pelargonii (Kalt.), and Myzus persicae (Sulz.). A high temperature for 10 days following inoculation favors infection from juice inoculations. [Johnson 1929, Dykstra & Whitaker 1938].

Properties: Dilution tolerance 1:200; longevity in vitro 1 to 2 days; thermal inactivation 70-75° C [Johnson].

Remarks:

Identity of his K virus with Dykstra's E virus is considered probable but not certain [Köhler], one point of difference being the failure to transmit K virus mechanically, whereas leaf-rolling mosaic virus was transmitted by juice inoculation by Johnson.

Literature:

Dykstra, T. P. A study of viruses infecting European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 40-67. 1939

_____, and W. C. Whitaker. Experiments on the transmission of potato viruses by vectors. Jour. Agric. Res. 57: 319-334. 1938.

Folsom, Donald. Virus diseases of the potato. Rept. Quebec Soc. Protect. Plants 17: 14-29. 1926.

Johnson, James. The classification of certain virus diseases of the potato. Wisconsin Agric. Exp. Sta. Res. Bull. 87. 1-24. 1929

Köhler, E. Erfahrungen beim feldmässigen Abbau von künstlich blattrollinfizierten Kartoffeln (Sorte Kl.-sp. Wohltmann). (Untersuchungen über die Virus Krankheiten der Kartoffeln. V. Mitteilung). Arb. Biol. Reichsanst. Land- u. Forstw., Berlin-Dahlem 21: 517-529. 1935.

_____ Die wichtigsten Kartoffelkrankheiten und ihre Bekämpfung. Arb. Reichsnährst. 44. 1-64. 1938.

_____ Eine übersehene Kartoffelvirose. Naturwissenschaften 29: 390. 1941.

_____ Untersuchungen über das 'K'-Virus der Kartoffel. I Mittlg. Angew. Bot. 24: 118-130. 1942.

Schultz, E. S., and D. Folsom. Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25: 43-118. 1923.

Schultz, E. S., and D. Folsom. Infection and dissemination experiments with degeneration diseases of potatoes. Observations in 1923. Jour. Agric. Res. 30: 493-528. 1925.

POTATO AUCUBA MOSAIC VIRUS

Technical name(s):
Solanum virus 9 K. M. Smith 1937
Marmor aucuba Holmes

Synonyms:
Potato aucuba variegation Quanjer et al. 1919
Potato non-infectious chlorosis Murphy 1921
Potato aucuba mosaic Quanjer 1922
Potato aucuba mosaic virus Folsom 1926
Potato anecrotic mosaic virus (group) Quanjer 1931
Potato virus G Clinch, Loughnane & Murphy 1936

Name of disease: Aucuba mosaic (U. S., England, Netherlands)

Geographical distribution: United States (Maine, in experimental plots, not in commercial stocks; perhaps occasional elsewhere but specific reports lacking); Canada [Murphy 1921]; Great Britain and throughout continental Europe, occasional on a number of different vars., never prevalent; Brasil, Chile, Peru; Rhodesia.

Host range:

SOLANACEAE -- *Solanum tuberosum L.

Atropa belladonna L., Capsicum frutescens L., Datura stramonium L., Hyoscyamus niger L., Lycopersicon esculentum Mill., Nicotiana glutinosa L., N. sylvestris Speg., N. tabacum L., Petunia hybrida Vilm., Solanum dulcamara L., S. nigrum L. var. nodiflorum.

Symptoms: In potato foliage, small, round, bright yellow spots about 4 mm in diam., sometimes coalescing to form patches [Dykstra 1939]; starch accumulation [Clinch et al.]; intracellular inclusions absent [Clinch]; parenchymatous necrosis in tubers of some vars. [Clinch et al.], none in tested American vars. [Dykstra]. On other hosts yellow spotting, blotching or mottling of foliage, sometimes necrotic spotting, or symptomless [Quanjer 1921, 1923; Clinch et al.]

Means of transmission: By sap, readily [Clinch et al.], by grafting [Quanjer]. Not by insects [Clinch et al., who tested Myzus persicae (Sulz.); and Elze, who tested Macrosiphum solanifolii (Ashm.), Myzus persicae, (M. pseudosolani Theob.) = M. convolvuli (Kalt.), and others.] By seed [Elze].

Properties: Passes L1 Pasteur-Chamberland filter, not L3 and L5 [Clinch et al.]; dilution tolerance 1:200 [Clinch], 1:50 [Dykstra]; longevity in vitro 4 days; thermal inactivation 63-65° C [Clinch], 65-68° C [Dykstra]; tolerates pH 4.2 but not 3.8 for 24 hours in sodium phos-

phate-citric acid buffer. Serologically unrelated to other potato mosaics, tobacco mosaic, tobacco ringspot, and other viruses of the Solanaceae [Chester].

Remarks:

Based on precipitin reactions, the aucuba mosaic virus belongs to the potato X virus group [Mushin]. Köhler obtained 3 variant forms of tobacco ringspot virus from potato plants with symptoms resembling aucuba mosaic.

Literature:

Chester, K. Starr. Serological evidence in plant virus classification. Phytopath. 25: 686-701. 1935.

Clinch, Phyllis E. M. Cytological studies of potato plants affected with certain virus diseases. Sci. Proc. Roy. Dublin Soc. N. S. 20: 143-172. 1932.

_____, J. B. Loughnane, and Paul A. Murphy. A study of the aucuba or yellow mosaics of the potato. Sci. Proc. Royal Dublin Soc. 21: 431-448. 1936

Dykstra, T. P. A study of viruses causing yellow mosaics in European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 917-933. 1939.

Elze, D. L. Die Übertragbarkeit mit dem Samen von Aukuba-Mosaik sowie Blattroll (Phloemnekrose) der Kartoffel. Phytopath. Zeitschr. 3: 449-457. 1931.

Folsom, Donald. Virus diseases of the potato. Rept. Quebec Soc. Protect. Plants 17: 14-29. 1926.

Köhler, E. Das Tabak-Ringspot Virus als Erreger einer Gelbfleckigheit des Kartoffellaubes. Angew. Bot. 22: 385-399. 1940.

Murphy, Paul A. Investigations of potato diseases. Canada Dept. Agric. Div. of Botany Bull. 44: 1-86. 1921.

Mushin, Rose. Serological studies on plant viruses. Australia Jour. Exp. Biol. and Med. Sci. 20: 59-63. 1942.

Quanjer, H.M. New work on leaf curl and allied diseases in Holland. Rept. Intern. Potato Conf. Roy. Hort. Soc. London 1921. pp. 127-145. 1922.

_____ General remarks on potato diseases of the curl type. Rept. Intern. Conf. Phytopath. & Econ. Ent. Holland 1923. pp. 23-28. 1923.

_____ The methods of classification of plant viruses, and an attempt to classify and name potato viroses. Phytopath. 21: 577-613. 1931.

_____, J. C. Dorst, M. J. Dijt, and A. W. v. d. Haar. De mozaiekziekte van de Solanaceeën hare verwantschap met de phloemnecrose en hare beteekenis voor de aardappelcultuur. Meded. Landbouwhoogesch. Wageningen 17. 1-74. 1919.

POTATO TUBER-BLOTCH VIRUS

Technical name(s):

Solanum virus 8 K. M. Smith 1937
Marmor aucuba Holmes 1939

Synonyms:

Potato net necrosis Atanasoff 1926; not net necrosis Orton 1914 and subsequent American authors.
Potato pseudo-netnecrosis Quanjer et al. 1929
Potato phloem-parenchyma necrosis virus Quanjer 1931
Potato tuber-blotch virus Loughnane & Clinch 1935, Murphy 1935
Potato virus F : Clinch et al. 1936

Names of diseases: Tuber Blotch, Hereditary Sprain (Great Britain); Pseudonetnecrose (Netherlands); Vererbliche Eisenfleckigkeit (Germany); Maculatura Interna Ereditaria (Italy). Not to be confused with internal brown spot, rust spot, sprain, kringerigheid, Propfenbildung, or maladie des tâches en couronne, which are not tuber-transmitted.

Geographical distribution: Great Britain, Germany, Netherlands, Italy, Australia, Peru.

Host range:

SOLANACEAE -- *Solanum tuberosum L.

Atropa belladonna L., Capsicum frutescens L., Datura stramonium L., Hyoscyamus niger L., Lycopersicon esculentum Mill., Nicotiana glutinosa L., N. sylvestris Speg., N. tabacum L., Petunia hybrida Vilm., Solanum dulcamara L., S. nigrum L. var. nodiflorum, S. racemosum L.

Symptoms: In potato, most characteristic in tubers, consisting of necrotic blotches in pith and cortex, starting at stem end, often extending throughout and appearing externally as irregular, dark, sunken lesions; symptoms sometimes absent in foliage [Quanjer] or mild [Clinch et al.], consisting of interveinal rustiness and small, round, yellow spots; presence of veinal mosaic virus (potato virus A) greatly intensifies the spots, producing a yellow variegation in some vars. In American potato vars. the foliage symptoms include yellow or necrotic blotches, yellowing and defoliation; tuber symptoms resemble those of Canada streak but milder [Dykstra]. In Nicotiana glutinosa and N. tabacum yellow or necrotic spots and blotches; in peppers necrotic spots in leaves, stem-streak, and leaf dropping [Dykstra]; symptomless or faint mottle in tobacco, local lesions and vein-clearing in Solanum nigrum var. nodiflorum [Clinch et al.].

Means of transmission: By sap (leaf rubbing); by grafting; by Myzus persicae (Sulz.) when virus A also is present [Clinch et al.]

Properties: Passes L1 but not L3 Chamberland filter; dilution tolerance 1:100; longevity in vitro 3 days; thermal inactivation 62-65° C; pH tolerance 4.2 to 3.8, 24 hrs. Immunologically related to aucuba-mosaic and Canada-streak viruses. [Clinch et al.]

Literature:

Atanasoff, D. Net necrosis of potato. Phytopath. 16: 929-940. 1926
Clinch, Phyllis E. M., J. B. Loughnane, and Paul A. Murphy. A study of the aucuba or yellow mosaics of the potato. Sci. Proc. Roy. Dublin Soc. N. S. 21: 431-448. 1936

Dykstra, T. P. A study of viruses causing yellow mosaics in European and American varieties of potato, Solanum tuberosum. Phytopath. 29: 917-933. 1939

Loughnane, J. B., and Phyllis E. M. Clinch. Composition of interveinal mosaic of potatoes. Nature 135: 833. 1935.

Murphy, P. A. Identity and spread of some potato viruses of the mosaic group. Proc. Sixth Intern. Congr. Bot. Amsterdam 1935 (2): 198-199. 1935

Quanjer, H. M. The methods of classification of plant viruses, and an attempt to classify and name potato viroses. Phytopath. 21: 577-613. /1931

_____, T. H. Thung, and D. L. Elze. "Pseudonetnecrose" van de aardappel. Meded. Landbouw. Wageningen 33 (9): 1-10. 1929.

POTATO CANADA-STREAK VIRUS

Technical name(s):
Marmor aucuba Holmes var. canadense Black & Price 1940

Synonyms:
Potato streak virus Koch & Johnson 1935, in part
Potato Canada streak virus Dykstra 1939
Marmor aucuba Holmes 1939
Virulent tuber blotch virus Clinch 1941

Name of disease: Canada streak

Geographical distribution: Canada (Nova Scotia); Ireland

Host range:
SOLANACEAE -- *Solanum tuberosum L.
Nicotiana glutinosa L., N. sylvestris Speg., N. tabacum L.

Symptoms: In potato, vars. Earliest of All and Green Mountain, rugosity and downward rolling of leaves, veinal necrosis, yellow or necrotic blotches; in Irish Cobbler, numerous necrotic spots, sometims yellow blotches; in other vars. symptoms range from aucuba-like spotting to severe necrosis and defoliation; tubers show an internal blotchy necrosis, starting in the pith, usually at the stem end and spreading throughout, becoming evident about 2 months after harvest. In Nicotiana spp., yellow or necrotic spots and blotches [Dykstra].

Means of transmission: By sap; not by insects (Myzus circumflexus (Buckt.), Macrosiphum pelargonii (Kalt.), and M. solanifolii (Ashm.) tested). [Dykstra]

Properties: Passes L1 but not L3 Chamberland filter; dilution tolerance 1:200 [Clinch], 1:500 [Dykstra]; longevity in vitro 4 days at 1:10 dilution, 15° C; thermal inactivation 62° C [Clinch], 65-68° [Dykstra]; pH tolerance 4.2 but not 3.8, 24 hrs. Serologically related to aucuba

mosaic and tuber blotch viruses [Clinch, Dykstra]; no immunological relationship with potato-calico virus, Marmor medicaginis var. solani [Black & Price].

Remarks:

Differs from tuber-blotch virus in causing a fatal top necrosis in Irish Chieftain, Bliss Triumph, and other potato vars. According to Clinch this is the potato-streak virus detected by Koch & Johnson in a sample of President potatoes from Ireland.

Literature:

Black, L. M. and W. C. Price. The relationship between viruses of potato calico and alfalfa mosaic. Phytopath. 30: 444-447. 1940.

Clinch, Phyllis E. M. A strain of tuber blotch virus causing top necrosis in potato. Sci. Proc. Roy. Dublin Soc. N. S. 22: 435-445. 1941.

Dykstra, T. P. A study of viruses causing yellow mosaics in European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 917-933. 1939.

Koch, K., and James Johnson. A comparison of certain foreign and American potato viruses. Ann. Appl. Biol. 22: 37-54. 1935.

POTATO LEAFROLL VIRUS

Technical name(s):

Solanum virus 14 K. M. Smith 1937

Corium solani Holmes 1939

Synonyms:

Blattrollkrankheit Appel 1906
(Distinguished from "Kräuselkrankheit", a general name previously applied to potato diseases of the degeneration type)

Phloemnekrose Quanjer 1913

Potato leaf-roll Pethybridge 1912
(Suggested as more precise than the old term "curl" as used in England and Ireland)

Potato phloem-necrosis (leaf-roll) virus Quanjer, Van der Lek & Oortwijn Botjes 1916

Potato virus 1 J. Johnson in K. M. Smith 1935

Name of disease: Leafroll
(This name is much more widely used and understood in English-speaking countries than phloem-necrosis; neither symptom is strictly diagnostic.)

Geographical distribution: Probably worldwide; recorded throughout North America and Europe; also in South America (Argentina, Brasil, Peru); Africa (French Morocco, Rhodesia, South Africa); Asia (China, Dutch East Indies, India, Japan); Australia and New Zealand.

Host range:

SOLANACEAE -- *Solanum tuberosum L., *S. nigrum L.

Atropa belladonna L., Datura stramonium L., D. tatula L., Hyoscyamus niger L., Lycopersicon esculentum Mill., Nicotiana tabacum L., Solanum dulcamara L., S. villosum Willd. [Quanjer 1923, Dykstra 1933].

All potato vars. and seedlings thus far tested have proved susceptible in some degree although differences have been noted in the readiness with which they become infected [Folsom 1944]. Some vars. are resistant to the net necrosis phase of leafroll. Transmission of the potato leafroll virus to Matthiola, Campanula, turnip, and Brussels sprouts has been claimed [Salaman & Wortley], but is not supported by the more extensive tests by Helson & Norris of the transmissibility of this virus to various Cruciferae.

Symptoms: Upward, longitudinal rolling of leaflets, evident first in the lower leaves of plants developing from infected tubers and progressing upward until all the leaves are affected; in initially healthy plants which become infected late in the season, rolling is limited to the upper leaves. A pronounced change in leaf texture occurs, which is readily evident to the touch, owing to thickening and loss of succulence. Starch translocation from the leaves is notably retarded. General dwarfing, diffuse chlorosis, reddish or purplish discoloration of leaves, abbreviation of stolons and reduction in number and size of tubers also ensue. Necrosis of the primary phloem, most evident in the lower part of the stem, is a reliable diagnostic feature [Sheffield]. In some vars., extensive phloem necrosis (net necrosis) develops in the tubers but disappears in subsequent tuber generations; affected tissue is fluorescent under ultra-violet [Sanford & Grimble]. Affected tubers sprout tardily and weakly; those showing net necrosis usually produce spindling sprouts [Schultz & Folsom 1921].

Properties: None determined owing to inability to transmit the virus by extracted juice; attempts to determine thermal tolerance in tubers showed that all surviving the treatments still carried the virus [Blodgett].

Means of transmission: By the aphids Macrosiphum solanifolii (Ashm.) and Myzus persicae (Sulz.) [Schultz & Folsom 1921, 1923; Murphy 1923; Elze 1927]. Detailed studies on the transmission of this virus by M. persicae have been reported by Murphy & McKay 1929, and especially by Smith 1929 and 1931. The latter found only this aphid among several species tested to be an efficient vector of leafroll virus, and postulated the existence of a special relation between the virus and its vector, thus a feeding period of 6 hours or longer is required for the insect to acquire the virus, and a further period of 48 hours must intervene before the virus can be transmitted; thereafter the virus can be transmitted successively to as many as 10 plants without the insect again feeding on one infected with leafroll. Though agreeing that M. persicae is the principal vector of leafroll virus, other investigators

have reported that different species of aphids possess this capacity, e. g. Aphis rhamni Boy. (A. abbreviata Patch) [Elze 1927, Folsom 1942]; more effectively if the infection-feeding period follows a period of non-feeding ("starvation") for 4 hours [Loughnane 1943]; A. fabae Scop.[Elze & Quanjer]; Myzus circumflexus (Buckt.) [Smith 1929, Whitehead 1930, McKay & Dykstra 1932, Dykstra & Whitaker 1938]; M. ornatus Laing [Loughnane 1939]; (M. solani (Kalt.), M. pseudosolani Theob) = M. convolvuli (Kalt.) [Elze, Smith, McKay & Dykstra, Dykstra & Whitaker.

Besides by aphids, leafroll virus transmission by the following insects has been claimed: Calocoris norvegicus (Gmelin), Miridae, and Typhlocyba ulmi (L.), Cicadellidae [Murphy & McKay 1923]; Eupteryx aurata (L.) Cicadellidae, Lygus pratensis (L.),Miridae, Psylliodes affinis (Payk.), Chrysomelidae, and Barathra (Mamestra) brassicae (L.), Phalaenidae, [Elze 1927]; in subsequent reports transmission only by P. affinis was claimed [Elze & Quanjer 1929, Elze 1931]; Empoasca fabae (Harris), Cicadellidae, [Cleveland].

Extensive tests by other investigators failed to demonstrate any vector capacity for this virus in insects other than aphids [Schultz & Folsom, Smith, Dykstra]. It has been shown that certain jassids may induce a leaf-rolling symptom in potato foliage that is not perpetuated through the tubers.

Transmissible also by stem grafts (readily), by tuber grafts (with difficulty); not by inoculation of expressed juice [Schultz & Folsom 1923]. By seed, rarely [Murphy & McKay 1924, Elze 1931]; however a non-virus leafroll simulating the virus disease also has been observed to occur in potato seedlings [Le Clerg].

Literature:

Appel, O. Neuere Untersuchungen über Kartoffel- und Tomaten-Erkrankungen. Jahresb. Ver.Vertr. f.Angew. Bot. 3: 122-136. 1906

Blodgett, F. M. Hot water and hot air treatments of potatoes. Phytopath. 13: 55. 1923

Dykstra, T. P. Weeds as possible carriers of leafroll and rugose mosaic of potato. Jour. Agric. Res. 47: 17-32. 1933.

_____, and W. C. Whitaker. Experiments on the transmission of potato viruses by vectors. Jour. Agric. Res. 57: 319-334. 1938

Elze, D. L. De verspreidung van virusziekten van de aardappel (Solanum tuberosum L.) door insekten. Meded. Landbouwhoogesch. Wageningen 31, 2. 1927.

_____ The relation between insect and virus as shown in potato leaf roll, and a classification of viroses based on this relation. Phytopath. 21: 675-686. 1931

_____ Die Übertragbarkeit mit dem Samen von Aucuba-Mosaik sowie Blattroll (Phloëmnekrose) der Kartoffel. Phytopath. Zeitschr. 3: 449-457. 1931.

_____, and H. M. Quanjer. Phloemnecrose en netnecrose van de aardappel in Amerika en Europa. Meded. Landbouwhoogesch. Wageningen 33, 8. 1929

Folsom, Donald. Potato virus disease studies with tuber-line seed plots and insects in Maine 1927 to 1938. Maine Agric. Exp. Sta. Bull. 410: 215-250. 1942

Folsom, Donald. Leafroll, including net necrosis. Resistant varieties. In Potatoes. Maine Agric. Exp. Sta. Bull. 426. 1944

Helson, G. A. H., and D. C. Norris. Transmission of potato virus diseases. 3. Susceptibility of Cruciferae to potato leaf roll virus. Jour. Coun. Sci. Industr. Res. Australia 16: 261-262. 1943

Le Clerg, E. L. Non-virus leafroll of Irish potatoes. Amer. Potato Jour. 21: 5-13. 1944

Loughnane, J. B. Myzus ornatus a vector of potato viruses. Nature 144: 785-786. 1939.

_____ Aphis rhamni Boyer; its occurrence in Ireland and its efficiency as a vector of potato viruses. Jour. Eire Dept. Agric. 40: 291-298. 1943

McKay, M. B., and T. P. Dykstra. Potato virus diseases, Oregon investigations 1924-1929. Oregon Agric. Exp. Sta. Bull. 294. 1-40. 1932

Murphy, Paul A. Investigations on the leaf-roll and mosaic diseases of potatoes. Jour. Dept. Agric. & Techn. Instr. Ireland 23: 20-34. 1923.

_____ The leaf-roll disease of potatoes: A summary of modern knowledge. Jour. Dept. Agric. Eire 35: 1-19. 1938.

_____ , and Robert McKay. Investigations on the leaf-roll and mosaic diseases of the potato. Jour. Dept. Agric. & Techn. Instr. Ireland 23: 344-364. 1924

_____ , and _____ The insect vectors of the leaf roll disease of the potato. Sci. Proc. Roy. Dublin Soc. N. S. 19: 341-353. 1929

Oortwijn Botjes, J. G. De bolziekte van de aardappelplant. 136 p. (Diss. Landbouwhoogesch. Wageningen) 1920

Pethybridge, G. H. Investigations on potato diseases. Jour. Dept. Agric. & Techn. Instr. Ireland 12: 1-28. 1912.

_____ History and connotation of the term "Blattrollkrankheit" (leaf-roll-disease) as applied to certain potato diseases. Phytopath. Zeitschr. 12: 283-291. 1939

Quanjer, H. M. Die Nekrose des Phloëms der Kartoffelpflanze, die Ursache der Blattrollkrankheit. Meded. Rijks Hoogere Land, Tuin en Boschbouwsch. 6: 41-81. 1913.

_____ General remarks on potato diseases of the curl type. Rept. Intern. Conf. Phytopath. & Econ. Ent. Holland 1923: 23-28. 1929

_____ , H. A. A. Van der Lek, and J. Oortwijn Botjes. Nature, mode of dissemination and control of phloem-necrosis (leaf-roll) and related diseases e. a. sereh. Meded. Rijks Hoogere Land, Tuin en Boschbouwsch. 10: 1-138. 12 pl. 1916

Salaman, R. N., and W. R. S. Wortley. Potential hosts of potato viruses in garden and field. Nature 144: 1049-1050. 1939

Sanford, G. B., and J. G. Grimble. Observations on phloem necrosis of potato tubers. Canad. Jour. Res. 22 C: 162-170. 1944

Schultz, E. S. and Donald Folsom. Leafroll, net-necrosis, and spindling sprout of the Irish potato. Jour. Agric. Res. 21: 47-80. 1921.

_____ and _____ Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25: 43-118. 1923

Sheffield, F. M. L. Value of phloem necrosis in the diagnosis of potato leaf-roll. Ann. Appl. Biol. 30: 131-136. 1943

Smith, K. M. Studies on potato virus diseases. V. Insect transmission of potato leaf-roll. Ann. Appl. Biol. 16: 209-229. 1929

_____ Studies on potato virus diseases. IX. Some further experiments on the insect transmission of potato leaf-roll. Ann. Appl. Biol. 18: 141-157. 1931

Whitehead, T. Transmission of potato leaf-roll. Nature 125: 974-975. 1930

POTATO SPINDLE-TUBER VIRUS

Technical name(s):
Solanum virus 12 K. M. Smith 1937
Acrogenus solani var. vulgaris Holmes 1939

Synonyms:
Potato spindle tuber Martin 1922
Potato spindling-tuber virus Schultz & Folsom 1923
Potato spindle-tuber virus Schultz & Folsom 1923
Potato virus 8 Johnson ex K. M. Smith 1935
(Not marginal leaf-roll Fernow 1923 or Quanjer 1923)

Name of disease: Spindle-tuber

Geographical distribution: United States, general; likewise in Canada and Newfoundland; also reported in Australia, China, Poland, Russia, ?Brasil, Chile, Venezuela.

Host range:

SOLANACEAE -- *Solanum tuberosum L., all tested vars.
Other plants not tested.

Symptoms: In general, affected plants are more erect, narrow, and tapering than normal plants, and appear to lack vigor; the stems are stiff and reduced in diameter, especially in the internodes; the leaves are dwarfed, erect, darker green than normal, the petioles are slender and sometimes brittle; tubers elongated (length:width ratio increased), tend to be pointed at both ends, especially the bud end; often irregular, eyes conspicuous, "staring". Round-tubered vars. show tuber elongation most conspicuously; in vars. with colored tubers, the color is duller, paler, and tends to be blotchy; russet-tubered vars. tend to become smooth. These symptoms are accentuated by high soil moisture and temperature.

Means of transmission: By sap (leaf rubbing, needle punctures, contact with macerated infected tissue and between freshly cut tubers); by stem and tuber grafts; by various insects, including aphids (Myzus persicae (Sulz.), Macrosiphum solanifolii (Ashm.)), flea beetles (Epitrix cucumeris (Harris) and Systena taeniata (Say)), leaf beetles (Disonycha triangularis (Say) and larvae of Leptinotarsa decemlineata (Say)), tarnished plant bug (Lygus oblineatus (Say)), grasshopper

(Melanoplus spp.) [Goss 1931].

Properties: Thermal inactivation in plugs of tuber tissue at 65° C in 10 min. [R. W. Sampson, communicated by Goss 1931]. Dilution tolerance in juice (leaves) 1:1000, ? 1:10,000. Longevity in extracted juice less than 24 hours, in drying foliage at least 1 week but not for 17 days [Goss 1931].

Literature:

Folsom, Donald. Potato spindle-tuber. Maine Agric. Expt. Sta. Bull. 312: 21-44. 1923

Goss, R. W. The symptoms of spindle tuber and unmottled curly dwarf of the potato. Nebraska Agric. Expt. Sta. Res. Bull. 47: 1-39. 1930.

_____ Infection experiments with spindle tuber and unmottled curly dwarf of the potato. Nebraska Agric. Expt. Sta. Res. Bull. 53. 1931

Martin, W. H. Spindle tuber, a new potato trouble. Hints to Potato Growers, New Jersey State Potato Assoc. 3 (8): 1922.

Schultz, E. S., and Donald Folsom. Spindling-tuber and other degeneration diseases of Irish potatoes. Phytopah. 13: 40. 1923.

_____, and _____ A "spindling-tuber disease" of Irish potatoes. Science n. s. 57: 149. 1923

_____, and _____ Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25: 43-118. 1923.

POTATO UNMOTTLED CURLY-DWARF VIRUS

Technical name(s):

Solanum virus 13 K. M. Smith 1937
Acrogenus solani var. severus Holmes 1939

Synonyms:

Potato virus 9 Johnson ex K. M. Smith 1935
Severe spindle tuber Goss 1924

Name of disease: Unmottled curly dwarf

Geographical distribution: United States (Maine, ?Mont., Nebr., ?N. Dak.)

Host range:

SOLANACEAE -- *Solanum tuberosum L., especially Green Mountain and Bliss Triumph vars.

Symptoms: In tops, pronounced dwarfing, spindliness, dark green color early in season, wrinkling, rugosity, uprightness, brittleness, burning; tubers spindleshaped or irregular, often gnarled and cracked.

Means of transmission: As for spindle-tuber virus, except the beetle Disonycha triangularis (Say) failed to transmit this virus. More readily transmitted by juice than spindle-tuber virus [Goss 1931].

Properties: Thermal inactivation in extracted juice above 75° C. Dilution tolerance at least 1:1000 [Goss 1931]. Longevity in vitro not determined.

Remarks:

Since the symptoms induced by this virus are consistently different from those of spindle tuber, it appears to be a related but distinct strain and not merely a progressive development of the latter virus [Schultz & Folsom 1923, Goss 1930]. Relationship to other potato viruses unknown.

Literature:

Same as for spindle-tuber virus

POTATO WITCHES'-BROOM VIRUS

Technical name(s):

Solanum virus 15 K. M. Smith 1937
Chlorogenus solani Holmes 1939
Chlorophthora solani (Holmes) McKinney 1944

Synonyms:

? Potato yellow-top degenerate Whipple 1919
? Potato witches' broom Bisby & Tolaas 1920
? Hereditary spindling sprout Coons & Kotila 1923
Potato witches' broom Hungerford & Dana 1924
Potato yellow top virus Folsom 1926, in part
Potato witches'-broom virus Young & Morris 1928
Tomato witches'-broom virus Young & Morris 1928
Tobacco witches'-broom virus Young 1929
? Potato wilding Murphy & McKay 1932
? Potato virus 11 J. Johnson in K. M. Smith 1935

Name of disease: Witches'-broom

Geographical distribution: United States (Fla., Idaho, Iowa, Kans., Me., Mich., Mont., Nebr., N. Dak., Oreg., Texas, Utah, Wash., W. Va., Wis., Wyo.); Canada (Alta., B. C., Man., N. B., N. S., P. E. I., Sask.); also reported in Australia, China, Poland, Russia.

Host range:

SOLANACEAE -- *Solanum tuberosum L.
Lycopersicon esculentum Mill., Nicotiana glutinosa L., N. rustica L., N. tabacum L.

APOCYNACEAE -- Vinca rosea L.

CHENOPODIACEAE --Beta vulgaris L. (sugar beet).

Symptoms: In potato, in primary (current season) infection, apical leaves become slightly rolled, upright, light green with reddish or yellowish margins; proliferation of axial buds, tendency to bloom and set fruit, production of aerial tubers and numerous small subterranean

tubers, often in bead-like arrangement, which tend to sprout without a rest period. Infected tubers produce thin branching sprouts (spindling sprout, hair sprout) from all or most of the eyes, giving rise to dwarfed, extremely bushy plants that have thin smooth stems, and small, simple, roundish or heart-shaped leaves. In tomato, flavescence, proliferation, extreme dwarfing, early death. In tobacco, proliferation, flavescence, dwarfing, acceleration of flowering.

Means of transmission: By tuber and stem grafts; by dodder (Cuscuta campestris Yuncker); not by juice or through seeds. Insect vector unknown.

Properties: The virus is inactivated in the tops of Vinca rosea by exposure to 36° C for 7 days or 42° for 3 days; in the roots also by 42° for 13 days. Potato tubers up to 3/4 inch diameter were freed of virus by 6 days exposure to 36° [Kunkel 1943].

Remarks:

This is one of several viroses (leafroll, purple-top wilt) of potatoes in which marked attenuation of sprouts occurs. The condition known as hair sprout may at times be a symptom of witches'-broom, but more frequently is due to one of the other viruses, or is non-persistent. Although this virus produces symptoms in Vinca rosea that are indistinguishable from those of aster yellows virus in this host, and the 2 viruses have similar thermal inactivation points, they differ in host and vector relations, since the aster leafhopper is unable to transmit the virus of witches'-broom, and the sugar beet is immune to the yellows virus but can be infected with witches'-broom virus via dodder. [Kunkel]

Literature:

Bisby, G. R., and A. G. Tolaas. Potato diseases in Minnesota. Minn. Agric. Exp. Sta. Bull. 190. 1-44. 1920

Coons, G. H., and J. E. Kotila. Michigan potato diseases. Michigan Agric. Exp. Sta. Bull. 125. 1-55. 1923.

Hungerford, C. W., and B. F. Dana. Witches'-broom of potatoes in the Northwest. Phytopath. 14: 372-383. 1924

Jaczewski, A. Witches'-broom of potato. Materials for Mycology and Phytopathology 5 (2): 117-128. 1926. (In Russian). From abst. in R. A. M. 6: 746. 1927

Kunkel, L. O. Potato witches'-broom transmission by dodder and cure by heat. Proc. Amer. Phil. Soc. 86: 470-475. 1943.

_____ New hosts as a key to progress in plant virus disease research. In Rockefeller Institute for Medical Research: Virus Diseases, pp. 65-82. Cornell Univ. Press, Ithaca, N. Y. 1943

Murphy, P. A., and R. McKay. A comparison of some European and American virus diseases of the potato. Sci. Proc. Roy. Dublin Soc. N. S. 20: 347-358. 1932

Young, P. A. Tobacco witches'-broom. A preliminary report. Amer. Jour. Bot. 16: 277-279. 1929

_____, and H. E. Morris. Witches'-broom of potatoes and tomatoes. Jour. Agric. Res. 36: 835-854. 1928

POTATO YELLOW-DWARF VIRUS

Technical name(s):
Solanum virus 16 K. M. Smith 1937
Marmor vastans Holmes 1939
Marmor vastans var. vulgare Black 1940
Marmor vastans var. lethale Black 1940
Marmor vastans var. agalliae Black 1941

Synonyms:
Potato yellow dwarf Barrus & Chupp 1922
Potato virus 5 J. Johnson in K. M. Smith 1935
Potato yellow-dwarf virus Black 1936

Name of disease: Yellow dwarf

Geographical distribution: United States (Fla., Ind., Me., Md., Mass., Mich., Minn., N. H., N. J., N. Y., Ohio, Pa., Vt., Va., W. Va., Wis.); Canada (Alta., B. C., Ont., Queb.)

Host range:

SOLANACEAE -- *Solanum tuberosum L., all tested vars., though some, as Chippewa, Houma, Katahdin, Russet Burbank, Sebago, and Warba, largely escape infection in the field.

Hyoscyamus niger L., Lycopersicon esculentum Mill., Nicotiana glauca R. Grah., N. glutinosa L., N. langsdorfii Weinm., N. paniculata L., N. rustica L., (X) N. sanderae Hort., N. sylvestris Speg., N. tabacum L., N. undulata Ruiz & Pav., Physalis heterophylla Nees, P. pubescens L., Solanum acaule Bitter, S. ajuscoënse Bukasov, S. antipovichi Bukasov, S. cardiophyllum Lindl., S. melongena L., S. neo-antipovichi Bukasov, S. verrucosum Schlecht.

COMPOSITAE -- *Chrysanthemum leucanthemum L. var. pinnatifidum Lecoq & Lamotte, *Rudbeckia hirta L.

Anthemis cotula L., Callistephus chinensis Nees, Cichorium intybus L., Galinsoga ciliata (Raf.) Blake, Tragopogon pratensis L.

CRASSULACEAE -- Kalanchöe daigremontiana (Ham. & Per.) Berger

CRUCIFERAE -- *Barbarea vulgaris R. Br.

Brassica nigra (L.) Koch, Capsella bursa-pastoris (L.) Medic., Erysimum cheiranthoides L., Lepidium campestre (L.) R.Br., L. virginicum L., Sisymbrium altissimum L.

LABIATAE -- Leonurus cardiaca L.

LEGUMINOSAE -- *Trifolium pratense L.

Medicago lupulina L., Trifolium agrarium L., T. hybridum L., T. incarnatum L., T. medium L., T. repens L., Vicia faba L.

POLYGONACEAE -- Rumex crispus L., R. obtusifolius L.

SCROPHULARIACEAE -- Verbascum blattaria L., V. thapsus L.

Symptoms: In potato, yellowing and dwarfing of apical parts, often accompanied by necrosis; rugosity, vein-clearing, upward rolling of margins and downward curling of leaves accentuated with rise of temperature; brown spots or rusty specks in pith of stems; tubers few, undersized, close to stem, misshapen and cracked, with internal necrotic areas throughout. Tubers from infected plants usually but not always reproduce the disease. Different parts of a single tuber may produce healthy or diseased plants [Hansing 1943]. Infected tubers may sprout normally and produce only slightly dwarfed plants when the soil temperature is low (16° to 20° C), but emergence is reduced and disease symptoms are accentuated at 24° C; at higher temperatures germination is suppressed though the sets may persist in the ground for several weeks and later sprout normally [Walker & Larson]

In crimson clover and red clover the symptoms consist of a veinal mosaic and yellowing of leaves; in ox-eye daisy (Chrysanthemum leucanthemum var. pinnatifidum) infected plants show vein clearing, reduction of leaf size, distortion and rigidity of leaves, and rosetting of the apical parts [Hansing 1943]. In certain vars. of Nicotiana rustica, yellow primary lesions are produced followed by systemic veinal chlorosis [Black 1938].

Means of transmission: By sap (needle puncture and leaf rubbing) with difficulty; by stem and tuber grafts. By the clover leafhoppers Aceratagallia sanguinolenta (Prov.) and Agallia constricta Van Duzee, the former transmitting only the var. vulgare, the latter only the var. agalliae, of the virus. The virus survives in the overwintering adult insects. Hereditary differences in ability to transmit the virus have been detected, giving rise to active and inactive races. Nymphs may transmit the virus, but it does not pass from parents to progeny through eggs or sperm. [Black 1941, 1943]. Reports of transmission by other insects -- Myzus persicae (Sulz.) by Koch (1934), and Empoasca fabae (Harris) and Macrosiphum solanifolii (Ashm.) by Muncie (1935) -- have not been confirmed.

Properties: Passes Berkefeld W filter; thermal inactivation 50-52° C; longevity in vitro 13 hrs. in juice at 23° C; in partially purified virus preparations infectiousness was retained for 30 days at 0° C, but was lost in 1 hour at pH 4 or 12, the alkaline stability being greater [Black 1938, 1941].

Remarks:

In addition to the 2 named "field" strains of the virus, several strains have been detected in artificial culture, differing in symptoms induced in potato (Green Mountain var.) and Nicotiana rustica [Black 1940]. A relationship has been suggested, possibly of the order of strains, between the viruses of potato yellow-dwarf and tobacco streak [Valleau]; however, from cross-protection tests, Price & Black concluded that the potato yellow-dwarf virus was not related to the viruses of tobacco streak, potato ringspot, potato veinbanding, cucumber mosaic, and

alfalfa mosaic. This virus might be more logically described on one of its perennial hosts, in particular one with which its insect vectors are associated in nature. It has been shown that the introduction of the virus into potatoes depends on the migration of the vectors from these hosts, and its current season dissemination between potato plants is of minor importance [Hansing & Frampton]. However, its economic importance on potatoes appears to justify its inclusion in the category of potato viruses.

Literature:

Barrus, M. F., and C. C. Chupp. Yellow-dwarf of potatoes. Phytopath. 12: 123-132. 1922.

Black, L. M. Some insect and host relationships of the potato yellow dwarf virus. Phytopath. 26: 87. 1936

_____ A study of potato yellow-dwarf in New York. Cornell Univ. Mem. 209. 1-23. 1937

_____ Properties of the potato yellow-dwarf virus. Phytopath. 28: 863-874. 1938

_____ Strains of potato yellow-dwarf virus. Amer. Jour. Bot. 27: 386-392. 1940

_____ Hereditary variation in the ability of the clover leafhopper to transmit potato yellow-dwarf virus. Phytopath. 31: 3. 1941

_____ Partial purification of potato yellow-dwarf virus. Phytopath. 31: 3. 1941

_____ Some relationships between potato yellow-dwarf virus and the clover leafhopper. Phytopath. 33: 363-371. 1943

Hansing, E. D. A study of the control of the yellow-dwarf disease of potatoes. Cornell University Agric. Exp. Sta. Bull. 792. 1-28. 1943

_____, and V. L. Frampton. The dissemination of yellow-dwarf of potatoes and its leafhopper vector, Acerata gallia sanguinolenta. Phytopath. 30: 7. 1940

Koch, Karl. Aphid transmission of potato yellow dwarf. Phytopath. 24: 1126-1127. 1934

Muncie, J. H. Yellow dwarf disease of potatoes. Mich. Agric. Exp. Sta. Bull. 260. 1-18. 1935

Price, W. C., and L. M. Black. Unrelatedness of tobacco streak and potato yellow-dwarf viruses. Amer. Jour. Bot. 28: 594-595. 1941

Valleau, W. D. A comparison of the viruses of streak of tobacco and yellow-dwarf of potato. Univ. of Kentucky Res. Club Bull. 6: 21-23. 1940

Walker, J. C., and R. H. Larson. Yellow-dwarf of potato in Wisconsin. Jour. Agric. Res. 59: 259-280. 1939

Younkin, S. G. Weed suscepts of the potato yellow dwarf virus. Amer. Potato Jour. 19: 6-11. 1942.

ALFALFA MOSAIC VIRUS

(Alfalfa strain)

Complete description under Medicago in Suppl. 154.

Potato infection: Experimental, by leaf-rubbing, not confirmed in nature.

(Potato calico strain)

Technical name(s):
Solanum virus 10 K. M. Smith 1937
Marmor medicaginis Holmes var. solani Black & Price 1940

Synonyms:
Potato calico Hungerford 1922
Potato calico virus Porter 1931

Name of disease: Potato calico

Geographical distribution: United States (Calif., Colo., Idaho, Iowa, Mich., Mont., Nebr., N. Y., N. Dak., Oreg., Texas, Utah, Wash.); also reported in Brasil, Bulgaria, and Hungary.

Host range:

SOLANACEAE -- *Solanum tuberosum L., *Capsicum frutescens L. (C. annuum L.) Datura stramonium L., Nicotiana glutinosa L., N. sylvestris Speg., N. tabacum L., Petunia sp., Solanum melongena L.

CUCURBITACEAE -- Cucumis sativus L.

LEGUMINOSAE -- Medicago sativa L., Phaseolus vulgaris L., Trifolium incarnatum L., T. pratense L., T. repens L., Vicia faba L., Vigna sinensis (Torner) Savi ex Hassk.

Symptoms: In potato, large, irregular, yellow to yellowish-white or gray spots and blotches on the leaves, covering veins and interveinal areas; because of chlorophyll deficiency plants infected when young are considerably reduced in size.

Means of transmission: By sap, readily between various hosts; by tuber grafts in a small proportion of trials; by the potato aphid Macrosiphum solanifolii (Ashm.) (M. gei (Koch)). [Porter, Dykstra].

Properties: Dilution tolerance not over 1:300, infection greatly reduced at dilutions above 1:10; longevity in vitro 2 days at 15° C; thermal inactivation at 40° C [Dykstra].

Remarks:
Tobacco and N. glutinosa plants infected with this virus are refrac-

tory to infection with alfalfa mosaic virus [Black & Price]; the presence of potato calico virus in Capsicum frutescens does not protect against infection by the viruses of the potato yellow mosaic group [Dykstra]. Accordingly this virus appears to be related to alfalfa mosaic virus but not to other potato viruses. It differs from the former in causing more pronounced symptoms in potato, but a milder reaction in tobacco, N. glutinosa, bean, and cowpea. Although the observed occurrence of infected potatoes in proximity to alfalfa plants exhibiting mosaic symptoms suggests natural spread between these plants, negative results were obtained from attempts to transmit a virus from one to the other [Porter 1935].

Literature:

Black, L. M., and W. C. Price. The relationship between viruses of potato calico and alfalfa mosaic. Phytopath. 30: 444-447. 1940

Dykstra, T. P. A study of viruses causing yellow mosaics in European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 917-933. 1939

Hungerford, C. W. Leaf roll, mosaic and certain other related diseases in Idaho. Phytopath. 12: 133-139. 1922

Porter, D. R. The infectious nature of potato calico. Hilgardia 6: 277-294. 1931

_____ Insect transmission, host range, and field spread of potato calico. Hilgardia 9: 383-394. 1935

CALLISTEPHUS (ASTER) YELLOWS VIRUS

Eastern or New York Strain

Complete description under Callistephus in Suppl. 150

Technical name:
Chlorogenus callistephi var. vulgaris Holmes

Synonyms (with reference to potato):
? Yellow-top Folsom 1926, in part
? Hereditary spindling sprout Kotila 1928
Moron disease Muncie 1932
Purple top Long 1935
Blue stem Orton & Hill 1937
Purple-top wilt Brentzel 1938
? Hair sprout Leach 1938
? Purple dwarf Sanford & Clay 1941

Name of disease: Purple-top wilt

Geographical distribution: United States (Iowa, Me., Md., Mass., Mich., Minn., N. Y., N. and S. Dak., Okla., Pa., R. I., W. Va., Wis.); Canada (Alta., Man., Sask.). Reported as purple dwarf in Colo., but identity with purple-top wilt uncertain.

Potato infection: Natural, in many vars., though differences in susceptibility have been noted; in some localities Rural New Yorker, Russet Rural, and Green Mountain reported very susceptible; in others Katahdin and Bliss Triumph; Sebago shows less tuber symptoms. Experimental, all vars. tested.

Symptoms: Dwarfing of apical parts of plant, upward folding and narrowing of terminal leaflets, loss of green color and replacement by a purplish tinge in leaf margins (yellow in Green Mountain), progressive extension of color changes to stems, with swelling of nodes and foreshortening of internodes; wilting first of apical parts then becoming general; proliferation of axillary buds and development of shoots from tips of stolons; production of aerial tubers; roots reduced in size and length, becoming brittle. A general brownish discoloration occurs in the vascular system of roots, stolons, stems and tubers, often followed by decay; net necrosis in stolon end of tubers; affected tubers produce spindling (hair) sprouts.

Means of transmission: By stem grafts between potato plants. By the 6-spotted aster leafhopper Macrosteles divisus (Uhl.) to potato from perennial and annual weeds, as Asclepias syriaca, Chrysanthemum leucanthemum var. pinnatifidum, Erigeron sp., Plantago major, and Ambrosia artemisiifolia; incubation period 26 days in Katahdin var., 35 in Green Mountain and Russet Rural. The vector is ordinarily unable to transmit the virus from potato plants (one successful instance reported by Severin) but transmission from potato to Nicotiana rustica can be effected by grafting, and thence to other hosts via the insect vector. Also transmissible between potatoes by tuber grafts [Epps] but not ordinarily tuber-perpetuated.

Properties: Not studied in potato; see Callistephus (aster) yellows virus for general properties.

Remarks:

In Maine 2 types of disease having purple top symptoms occur, one of which does not affect the seed quality of the tubers, which grow normally, and the other materially affecting them. The effect is, however, a general weakening rather than the perpetuation of the disease [Bonde]. See also "yellow-top", under "apical leaf roll", some examples of which are probably caused by this virus. In New York purple-top wilt is definitely associated with the eastern strain of aster yellows virus (Chlorogenus callistephi var. vulgaris) [Epps, Younkin]. Although doubt has been expressed at times that the potato disease first described as blue stem in West Virginia and Pennsylvania is identical with purple-top wilt, this conclusion is accepted by Leach and Bishop (1944), who find that potatoes become infected from viruliferous leafhoppers that have overwintered. The incubation period of the virus is longer in potatoes than in asters. Differences in symptom expression are related to the stage of growth when infection occurs. In Minnesota and North Daktoa anomalies have been noted in the distribution of aster yellows virus in weeds and crops other than potatoes in relation to the occurrence of purple-top wilt in potato, whence it is inferred that all instances classed as the latter disease may not be caused by this virus [Tervet].

Literature:

Brentzel, W. E. "Purple top" wilt of potato in North Dakota. U. S. Dept. Agric. Plant Dis. Rptr. 22: 44-45. 1938

Burke, O. D. The incidence of purple-top wilt in Pennsylvania on certain potato varieties. Phytopath. 31: 5. 1938

Epps, W. M. Purple-top wilt of potatoes. Cornell Univ. Abstracts of Theses 1942: 363-365. 1943.

Leach, J. G. Further experiments on the cause of "purple-top wilt" of potatoes. Phytopath. 29: 14. 1939

_____, and C. F. Bishop. Further studies on the nature and cause of purple-top wilt of potatoes. Phytopath. 34: 1006-1007. 1944

Long, H. D. Purple-top disease linked with hair sprout tubers. Iowa State Hort. Soc. Rept. 70: 314-316. 1935

Muncie, J. H. Yellow dwarf and "moron" disease of potatoes in Michigan. Proc. Potato Assoc. Amer. 1931: 70-73. 1932

Orton, C. R., and L. M. Hill. An undescribed potato disease in West Virginia. Journ. Agric. Res. 55: 153-157. 1937

Sanford, G. B., and S. B. Clay. Purple dwarf, an undescribed potato disease in Alberta. Canadian Journ. Res. C 19: 68-74. 1941

Tervet, Ian. Purple-top wilt of potato and the aster-yellows virus in the Dakotas. U. S. Dept. Agric. Plant Dis. Rptr. 28: 816. 1944. Also ibid 28: 800

Younkin, S. G. Purple-top wilt of potatoes caused by the aster yellows virus. Phytopath. 33: 16. 1943

Anonymous. Potatoes. Maine Agric. Exp. Sta. Ann. Rept. for 1941-42. Bull. 411. 281-343. 1942

California strain

Technical name:
Chlorogenus callistephi var. californicus Holmes

Geographical distribution: California

Potato infection: Natural, in California (rare); exptl. to Bliss Triumph, White Rose, and seedlings. Although first attempts to transmit the virus from potatoes to aster failed [Severin & Haasis], later attempts using the long-winged form of Macrosteles divisus were successful [Severin].

Symptoms: Dwarfed, inrolled leaflets, petioles curving downward; leaves and stems brittle, turning yellow and dying prematurely; purple aerial tubers; slender, purple sprouts produced by tubers from affected plants [Severin & Haasis].

Literature:

Severin, H. P. P. Potato naturally infected with California aster yellows. Phytopath. 30: 1049-1051. 1940

_____, and F. A. Haasis. Transmission of California aster yellows to potato by Cicadula divisa. Hilgardia 8: 329-335. 1934

BEET CURLY-TOP VIRUS

Technical name:
Chlorogenus cutetticola Holmes = Ruga verrucosans Carsner & Bennett

Potato infection: Natural, in Calif., Oreg., Wash., and Br. Col.; also experimental, by means of the sugar beet leafhopper, Eutettix tenellus (Baker), to 8 vars.

Symptoms: Apical parts stunted, flavescent; leaflets rolled inward, petioles curved downward; proliferation of axial buds; premature yellowing or reddening and death.

Literature:

Severin, H. H. P. Additional host plants of curly top. Hilgardia 3: 595-629. 1929

A complete description of the virus will be given under beet curly-top virus in a later supplement.

CRANBERRY FALSE-BLOSSOM VIRUS

Technical name:
Chlorogenus vaccinii Holmes

Potato infection: Experimental, from cranberry by dodder (Cuscuta campestris Yuncker), then by stem grafts between potato plants.

Symptoms: Not specifically described on potato but on other experimental hosts, e. g. tomato, the characteristic symptoms are virescence and enlargement of flowers and thickening of buds, sometimes attenuation and proliferation of shoots, chlorosis and dwarfing of foliage. The symptoms are similar to those of tomato big-bud virus, q. v. In the cranberry this virus is naturally transmitted by the leafhopper Euscelis striatulus (Fall.).

Literature:

Kunkel, L. O. False blossom in periwinkles and its cure by heat. Science n. s. 95: 252. 1942
_____ Viruses in relation to the growth of plants. Torreya 43: 87-95. 1943

CUCUMBER MOSAIC VIRUS

Technical name:
Marmor cucumeris Holmes

Potato infection: Reports in literature are conflicting in regard to infection of potatoes by cucumber mosaic virus. By using viruliferous aphids [? Aphis gossypii Glov.] from cucumber, mosaic symptoms were

induced in potato, and mosaic virus also was apparently returned by aphids from these potato plants to cucumbers [Doolittle & Walker]; however, attempts to transmit the virus from cucumber to potato by mechanical inoculation failed [Doolittle]. Negative results from both mechanical and aphid (not identified, ? A. gossypii) inoculations between potato and cucumber and squash were reported by Elmer. Transmission of this virus (cucumber virus 1) from cucumber to Triumph potatoes by mechanical inoculation was reported by Johnson (1927) but the induced symptoms were weak and the virus was difficult to recover from inoculated plants. Attempts to transmit 3 strains of cucumber mosaic virus by juice inoculation to seedling potatoes were unsuccessful, but one suspected instance of transmission to Irish Cobbler (without confirmation by reciprocal transfer) occurred, and in one instance transfer of this virus from naturally infected potato to tobacco was obtained [Valleau & E. M. Johnson]. The celery mosaic strain of cucumber mosaic virus could not be communicated by mechanical or aphid (A. gossypii) inoculation to potatoes of several varieties [Wellman]. Neither juice inoculations to potato from mosaic-infected cucumber, nor transmission by stem grafts with tobacco infected with this virus, were successful [Dykstra]. Natural infection of potato with a suspected but unproved cucumber mosaic virus also has been reported in Germany, but the susceptibility of potatoes to this group of viruses remains somewhat doubtful. This does not apply to the veinbanding or severe mosaic virus of potatoes (q.v.), which has been interpreted on serological evidence as a strain of cucumber mosaic virus, Marmor cucumeris var. upsilon Holmes [Chester, Holmes] but on other evidence appears to be a distinct virus.

Literature:

Chester, K. Starr. Serological evidence in plant virus classification. Phytopath. 25: 686-701. 1935

Doolittle, S. P. The mosaic disease of cucurbits. U. S. Dept. Agric. Bull. 879. 1920

_____, and M. N. Walker. Notes on cucurbit mosaic. Phytopath. 12: 42-43. 1922

Dykstra, T. P. A study of viruses infecting European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 40-67. 1939

Elmer, O. H. Transmissibility and pathological effects of the mosaic disease. Iowa Agric. Exp. Sta. Res. Bull. 82: 39-91. 1925

Folsom, Donald, and Reiner Bonde. List of distinct potato viroses. Amer. Potato Journ. 13: 14-16. 1936

Holmes, Francis O. Handbook of phytopathogenic viruses. 1939

Johnson, James. The classification of plant viruses. Wisconsin Agric. Exp. Sta. Res. Bull. 76. 1-15. 1927.

Valleau, W. D., and E. M. Johnson. The relation of some tobacco viruses to potato degeneration. Kentucky Agric. Exp. Sta. Bull. 309. 473-502. 1930.

Wellman, F. L. The host range of the southern celery-mosaic virus. Phytopath. 25: 377-404. 1935

TOBACCO ETCH VIRUS

Technical name:
Marmor erodens var. *vulgaris* Holmes

Potato infection: Experimental, by juice transfer.

Symptoms: In potatoes already containing the mottle (X) virus, inoculation with this virus induces symptoms of the rugose mosaic type, resembling the effect of inoculation with veinbanding virus, though with greater leaf distortion and larger but fewer chlorotic areas. The virus can be returned to tobacco by juice inoculation.

Literature:

Valleau, W. D., and E. M. Johnson. The relation of some tobacco viruses to potato degeneration. Kentucky Agric. Exp. Sta. Bull. 309. 473-502. 1932

TOBACCO MOSAIC VIRUS

Technical name:
Marmor tabaci (Holmes ex Valleau) McKinney

Potato infection: The natural occurrence of this virus in field-grown potatoes has not been observed in the United States although it has been reported in Germany by Kausche and others. Experimental transmission to potato has been reported a number of times, but with marked differences in the effects induced in different varieties. Schultz and Folsom (1923) were unable to transmit a virus from mosaic-infected tobacco to Green Mountain potatoes, but the virus concerned in this attempt was probably the cucumber mosaic virus (fide Schultz). Transmission of tobacco mosaic virus to the Bliss Triumph potato var. was accomplished by Johnson (1925), and to Green Mountain potatoes by Fernow (1925). In the former instance only local necrosis at the point of inoculation resulted; in the latter a systemic necrotic disease resembling streak occurred. The influence of the var. of potato upon the resulting symptoms was shown by Blodgett (1927), who transmitted tobacco mosaic from an authentic source to Triumph, Green Mountain, and Rural New Yorker potatoes. In the latter, in addition to necrotic spotting and streaking, systemic mottling resembling that of tobacco mosaic on its proper host developed. Marked symptoms developed only at temperatures of 26° C or above, and no symptoms could be detected at 15-18° C. Return of the virus to tobacco by juice inoculation also was accomplished, but the symptoms in tobacco were complicated by the latent virus that was present in the apparently healthy potatoes. Transmission of authentic tobacco mosaic virus was accomplished by juice inoculation to Irish Cobbler and seedling potatoes [Valleau & Johnson] and to Green Mountain [Folsom & Bonde]; also by grafting [Jones & Burk] but the Katahdin var. appeared to be immune.

Literature:

Blodgett, F. M. Tobacco mosaic on potatoes. Phytopath. 17: 727-734. 1927.

Fernow, K.H. Interspecific transmission of mosaic diseases of potato. Cornell University Agr. Exp. Sta. Mem. 96. 1-34. 1925

Folsom, Donald, and Reiner Bonde. Some properties of potato rugose mosaic and its components. Jour. Agric. Res. 55: 765-783. 1937

Johnson, James. Transmission of viruses from apparently healthy potatoes. Wisconsin Agric. Exp. Sta. Res. Bull. 63. 1-12. 1925

Jones, L. K., and E. F. Burk. The resistance of progeny of Katahdin potatoes to viroses. Jour. Agric. Res. 60: 631-644. 1940

Kausche, G. A. Über die Trennung von Virusgemischen auf Grund der unterschiedlichen Säuren-Basenempfindlichkeit ihrer Komponenten Angew. Bot. 20: 246-256. 1938

Schultz, E. S., and Donald Folsom. Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25: 43-118. 1923

Vahleau, W. D., and E. M. Johnson. The relation of some tobacco viruses to potato degeneration. Kentucky Agric. Exp. Sta. Bull. 309. 473-507. 1932

TOBACCO RINGSPOT VIRUS

Technical name:
Annulus tabaci Holmes

Potato infection: Natural, in Irish Cobbler var., perpetuated through 2 tuber generations; transmission to tobacco effected but not reciprocally [Valleau & E. M. Johnson]. Also reported in Germany, on several potato vars., from which 3 strains of the virus were isolated, all producing a characteristic severe ringspot in tobacco; in one var. tuber perpetuation occurred [Böhme, Köhler]. In both instances, the yellow strains of this virus were involved. Negative results in the experimental transmission of the typical strain from tobacco to potato have been reported several times, but it has been shown to be possible and to be influenced by the var., Early Rose, Green Mountain, and Triumph being susceptible, Irish Cobbler resistant [Henderson & Wingard].

Symptoms on potato: The typical strain causes non-systemic necrotic spots; the yellow strains cause systemic yellow spots typical of potato aucuba mosaic.

Literature:

Böhme, R. W. Einige Fälle spontaner Infektion mit echten Tabak-Ringflecken-Virus (Tobacco-ringspot). Phytopath. Zeitschr. 6: 507-515. 1933

Henderson, R. G., and S. A. Wingard. Further studies on tobacco ring spot in Virginia. Jour. Agric. Res. 43: 191-207. 1931

Köhler, E. Das Tabak-Ringspot Virus als Erreger einer Gelbfleckigkeit des Kartoffellaubes. Angew. Bot. 22: 385-399. 1940

Valleau, W. D., and E. M. Johnson. The relation of some tobacco viruses to potato degeneration. Kentucky Agric. Exp. Sta. Bull. 309. 473-507. 1930

TOMATO BIG-BUD VIRUS

Technical name:
Galla australiensis Holmes

Potato infection: Experimental, by grafting with tomato.

Symptoms on potato: General chlorosis, curling, and ultimately necrosis of leaf blades; sometimes aerial tubers producing apical leaf sprouts; subterranean tubers small and deformed [Poner]. The similarity of symptoms induced in the tomato by some strains of the cranberry false-blossom virus to those resulting from the big-bud virus has been emphasized by Kunkel, though there is no proof as yet that these viruses are identical.

Remarks:

The occurrence of this virus on tomatoes and possibly other plants, though not on potatoes, in the Pacific Northwest has been reported [Dana]. A wide range of host plants and an insect vector (Thamnotettix argentata Evans) of this virus have been reported in Australia [Hill 1943]. There is a marked similarity in the symptoms described by Hill in many plants to those of delphinium virescence or yellows as reported in the western United States, which is attributed to a strain of aster yellows virus and is transmitted by T. geminatus Van D. and T. montanus Van D. The tomato big-bud virus is of wide geographical distribution, having been reported in the Crimea, Georgia and Central Asia (U.S.S.R.), and (?) in India, besides Australia and the United States.

Literature:

Dana, B. F. Occurrence of big bud of tomato in the Pacific Northwest. Phytopath. 30: 866-869. 1940

Hill, A. V. Insect transmission and host plants of virescence (big bud) of tomato. Jour. Coun. Sci. Indust. Res. Australia 16: 85-90. 1943

Kunkel, L. O. Viruses in relation to the growth of plants. Torreya 43: 87-95. 1943

_____ New hosts as a key to progress in plant virus disease research. In Rockefeller Institute for Medical Research: Virus Diseases. pp. 65-82. Cornell Univ. Press, Ithaca, N. Y. 1943

Poner, V. M. In Plant Virus Diseases and their Control. Transactions of the conference on plant virus diseases, Moscow 4-7/II 1940. From abst. in R. A. M. 23: 216. 1944

TOMATO SPOTTED-WILT VIRUS

Technical name:
Lethum australiense Holmes

Potato infection: Experimental, by juice inoculation, by insects (Thrips tabaci Lind and Franklinella insularis Franklin), and by stem grafting [Sakimura, Parris]; also natural, in Australia, where systemic infection and perpetuation by tubers have been shown to occur [Magee, Bald], and in Brasil and South Africa. The tip-blight strain of this virus is transmissible to potato by juice inoculation but does not become systemic [Milbrath].

Symptoms on potato: Necrotic flecking, spotting, and streaking of apical parts, sometimes necrotic spotting, cracking, and distortion of tubers.

Literature:

Bald, J. G. Potato virus diseases, the scientist and the farmer. Fruit World, Melbourne 42 (6): 17-18; (7): 17-18. 1941. From abst. in R.A.M. 20: 592. 1941.

Magee, C. J. Spotted wilt of lettuce and potatoes. Agric. Gaz. New South Wales 47: 99-100, 118. 1936

Milbrath, J. A. Tomato tip-blight virus. Phytopath. 29: 156-168. 1939

Parris, G. K. Mechanical transmission of yellow-spot virus: evidence for its identity with spotted-wilt virus. Phytopath. 30: 299-312. 1940

Sakimura, K. Evidence for the identity of the yellow-spot virus with the spotted-wilt virus: experiments with the vector, Thrips tabaci. Phytopath. 30: 281-299. 1940

PART II. VIRUS AND VIRUSLIKE DISEASES OF THE POTATO

(References to literature not otherwise cited herein will be found in the bibliography following VEINAL MOSAIC VIRUS in Part I. Preferred names are underlined.)

ACRONECROSIS (ACRONEKROSE (G), TOP NECROSIS (E)[3]). Intr. by Quanjer (1931). Viroses characterized by necrotic centers originating in the internal phloem and extending into the surrounding parenchyma of leaves and stems with complete killing of tips of young shoots; in general, the reaction of an intolerant variety to a virus of the mottle (X) group, as Up-to-Date and President streak. However, certain viruses belonging to other groups as the Di Vernon streak or C virus of the severe mosaic group, and the tuber-blotch and Canada streak viruses of the yellow mosaic group, also may cause top necrosis in certain varieties. See MOTTLE, DI VERNON STREAK, TUBER-BLOTCH, and CANADA-STREAK VIRUSES in Part I.

[3] The following symbols are used: D = Denmark, E = England, F = France, G = Germany, H = Holland, S = Sweden.

ACROPETAL NECROSIS (NEKROSE (G), LEAF-DROP STREAK (E)). Intr. by Quanjer. Viroses characterized by necrosis in the collenchyma of leaf veins, petioles and stems, spreading upward, with dropping of lower leaves; in general the reaction to a virus of the severe mosaic (veinbanding, Y) group; also induced in some vars. by strains of mild mosaic (veinal, A) virus. See SEVERE MOSAIC (LEAF-DROP STREAK) VIRUS in Part I.

APICAL LEAFROLL. Identified as a distinct virosis by Schultz & Bonde 1929, and named Solanum virus 17 by K. M. Smith in 1937, with the following synonyms: Potato yellow top, Whipple 1919; Potato yellow-top virus, Folsom 1926, in part. The identity of a suspected virosis called potato yellow top by Goss in 1927 is unknown. Apical leafroll or yellow top has been reported in the U. S. in Me. and Mont., perhaps in Nebr.; a potato virosis under this name has also been reported in Hungary. In Maine the following vars. were infected: Bliss Triumph, Green Mountain, Irish Cobbler, Rose No. 4.

As described by Schultz and Bonde, the symptoms consist of slight dwarfing and rolling of upper leaves with persistence of this symptom only in the upper leaves in later tuber generations; shortening of stolons; tubers reduced in size but of normal shape and number. According to Folsom the tubers may exhibit net necrosis and produce thin weak sprouts. Schultz and Bonde considered the disease identified as apical leafroll to be transmissible by tuber grafts. No property studies have been reported. Although the disease appears to be definitely of virus nature, the virus has not yet been specifically identified or shown distinct. Potato yellow top in some vars. may result from the aster yellows virus. On the other hand, a yellow-top plant sent to Kunkel was identified as witches' broom.

Literature:

Folsom, Donald. Virus diseases of the potato. Rpt. Quebec Soc. Protect. Plants 17: 14-29. 1926.

_____, and Reiner Bonde. List of distinct potato viroses. Amer. Potato Jour. 13: 14-16. 1936.

[Goss, R. W.]. Plant diseases. In Nebraska Agric. Exp. Sta. Ann. Rept. 41: 25. 1928

Kunkel, L. O. Potato witches' broom transmission by dodder and cure by heat. Proc. Amer. Philos. Soc. 86: 470-475. 1943.

Schultz, E. S., and Reiner Bonde. Apical leafroll of potato. Phytopath. 19: 82-83. 1929.

Whipple, O. B. Degeneration in potatoes. Montana Agric. Exp. Sta. Bull. 190. 1919

APICAL LEAF SPECK. Observed in Alberta, Canada, in areas characterized by defective drainage and moisture-supplying capacity. Minute, interveinal, necrotic specks occur in the apical leaves, and irregular necrotic areas in the stem pith. Not tuber-perpetuated; believed to be of physiological origin. [Sanford, G. B. Apical leaf speck of potatoes. Sci. Agric. (Canada) 22: 772-774. 1942.]

AUCUBA MOSAIC. See AUCUBA MOSAIC VIRUS in Part I.

AUCKLANDER SHORT-TOP NECROSIS. An acronecrotic virosis latent in the New Zealand var. Aucklander Short-Top, and causing a severe top-necrosis in other vars.; a strain of mottle (X) virus (q.v.).

BIGARRURE (F) = SEVERE (VEINBANDING or STIPPLE-STREAK) MOSAIC without presence of mottle (X) virus. Cf. FRISOLÉE.

BLATTROLLKRANKHEIT (G), BLADROLZIEKTE (H), BLADRULLESYGE (D), BLADRULL-SJUKA (S) = LEAFROLL.

BLUE STEM = PURPLE-TOP WILT.

BOLTER. Variations from the normal growth habit taking the form of abnormally tall, coarse-stemmed, late-maturing plants; probably equivalent to GIANT HILL and of genetic origin (bud mutations).

BUKETTKRANKHEIT (G, H), BOUQUET (F). Said to be equivalent to curly dwarf and attributed to composite infection by ordinary mosaic (A or possibly X virus) together with stipple-streak (Y virus).

CALICO. See ALFALFA MOSAIC VIRUS, POTATO CALICO STRAIN, in Part I B.

CANADA STREAK. See CANADA-STREAK VIRUS in Part I.

CHOCOLATE SPOT. A tuber disorder of the internal brown spot type, occurring in Argentina; attributed to spotted wilt virus. [Fawcett, G. L. Circ. Estac. Exp. Agric. Tucuman 67. 1-3. 1938.]

CONCENTRIC NECROSIS. Intr. by Quanjer (1931). Localized necrosis in storage parenchyma of tubers, probably equivalent to spraing (E), maladie des tâches en couronne (F), kringerigheid (H), Propfenbildung (G), and probably to some types of internal brown spot (U.S.). Although not ordinarily perpetuated through seed tubers, at least one type of concentric necrosis is transmissible ty tuber grafts and is considered a virosis [Quanjer 1937].

CORCOVA (hunchback). Name used in Brasil for certain manifestations of tomato spotted wilt virus, or for the virus itself on various plants including potato.

CRINKLE (CRINKLE MOSAIC). In Britain applied to a complex virosis induced by veinal mosaic (A) virus together with mottle (X) virus; roughly equivalent to mild mosaic in the United States, especially the type induced by crinkle strains of virus A. Crinkle A is essentially synonymous. Some examples of crinkle are said to be caused by the severe mosaic (Y) virus together with the mottle (X) virus, or to the former alone, but these are probably more accurately to be identified as rugose or severe mosaic. See VEINAL (MILD) MOSAIC VIRUS in Part I.

CURLY DWARF. A symptom complex rather than a definite disease, the component viruses probably varying in different localities and potato varieties. In Green Mountain curly dwarf is caused by the viruses of spindle tuber and leaf-rolling mosaic together with the mottle (latent) virus. Sometimes used in a restricted sense as equivalent to severe (rugose) mosaic.

CURLY DWARF, UNMOTTLED = UNMOTTLED CURLY DWARF.

DI VERNON STREAK. Named by Salaman, 1930; caused by potato virus C Bawden, Solanum virus 5 K. M. Smith, which is latent in the Di Vernon var., and causes top necrosis in the President and some other vars. in England. Shown to be a necrotic strain of Y virus by Bawden and Sheffield, 1944. Demonstrated occurrence limited to the British Isles.

EISENFLECKIGHEIT (G) = INTERNAL RUST SPOT.

EISENFLECKIGHEIT, ERBLICHE (G) = PSEUDO-NET NECROSIS.

ENROULEMENT (F) = LEAFROLL.

FILOSITÉ (F) = SPINDLING SPROUT

FOLIAR MOTTLE. A strain of mottle (X) virus. See also PUNCTATE NECROSIS.

FOLIAR NECROSIS. Potato virus D, a virus of the mottle (X) group (q.v.)

FRISOLÉE (F) = RUGOSE MOSAIC or LEAF-DROP STREAK, caused by mottle (X) and veinbanding (Y) viruses.

GELBFLECKIGHEIT (YELLOW SPOT). A tuber disease resembling Eisenfleckigheit observed in the Kipfler var. in Austria; deep-yellow, translucent patches, becoming necrotic, occurred in tubers; cause unknown. [Wenzl, H. Phytopath. Zeitschr. 11: 607-616. 1939]

GIANT HILL. Intr. by E. L. Nixon about 1922. An abnormal condition of unknown cause occurring in certain potato stocks, especially of the Green Mountain, Rural New Yorker, Burbank, and Netted Gem vars.; perpetuated by seed tubers but not transmissible by grafting. It appears to be systemic and increases in plots if not eliminated by roguing. In the absence of a demonstrated etiological agent it is assumed to be due to a genetic abnormality or bud mutation.

Geographical distribution: United States (Fla., Me., Mich., Mont., Nebr., N. Y., Oreg., Pa., Vt., Wash.): Canada (B. C.); also reported in Denmark, Russia, and South Africa.

Symptoms: Oversized plants, with coarse thick stems and enlarged nodes; foliage somewhat lighter green than normal; prolonged flowering and late maturity; somewhat frost-resistant and therefore conspicuous by contrast after normal plants are killed by frost; leaves, especially the upper ones, somewhat undersized, the margins rolled upward, but of normal texture. Roots abnormally fibrous; stolons longer than normal. Tubers usually reduced in number, of uneven size and shape, often elongated and spindle-shaped; skin rough, eyes and lenticels often prominent. On the other hand, the tubers may be normal in size and shape although the plants exhibit the usual symptoms. The palisade mesophyll cells are smaller than normal and have a lower ratio of width to length; the inner phloem of stems is less extensive than in normal plants and less also in relation to the xylem.[Folsom et al.]

Literature:

Coons, G. H., and J. E. Kotila. Michigan potato diseases. Michigan Agric. Exp. Sta. Spec. Bull. 125. 454-506. 1924.

Dana, B. F. Mosaic and related diseases of potato and other crops. Washington Agric. Exp. Sta. Bull. 208. 1926

Folsom, Donald. Virus diseases of the potato. Quebec Soc. Protect. Plants (1925-26) 17: 14-29. 1926.

_____, and Reiner Bonde. List of distinct potato viroses. Amer. Potato Jour. 13: 14-16. 1936.

_____, F. V. Owen, and H. B. Smith. Comparisons of apparently healthy strains and tuber lines of potatoes. Maine Agric. Exp. Sta. Bull. 358. 1-104. 1931

_____, and E. S. Schultz. Methods to be observed to prevent spread of virus diseases in potatoes grown for seed stock. Proc. 11th Ann. Meet. Potato Assoc. Amer. 1924: 20-26. 1925

Gilbert, A. H. "Giant hill" potatoes a dangerous source of seed, a new phase of spindle-tuber. Vermont Agric. Exp. Sta. Bull. 245. 3-16. 1925.

Hill, Helen D. A comparative study of certain tissues of giant-hill and healthy potato plants. Phytopath. 24: 577-598. 1934

Kotila, J. E. Transmission studies of virus diseases of potatoes in Michigan, 1926-27. Proc. 14th Ann. Meet. Potato Assoc. Amer. 1927: 95-101. 1928

Lauer, K. W. Seed potato certification in Pennsylvania. Pennsylvania Dept. Agric. Gen. Bull. 471. 1-15. 1929

McKay, M. B., and T. P. Dykstra. Potato virus diseases. Oregon Agr. Exp. Sta. Bull. 294: 1-40. 1932

GLANZKRANKHEIT (gloss disease). A suspected virosis affecting potatoes and other plants in experimental greenhouse cultures in Germany. Caused glossy appearance of lower leaf surface, acronecrosis, leaf rolling, bronzing, and streak. Not transmissible by juice. [Köhler, E. Angew. Bot. 20: 373-380. 1938.]

GOTHIC. A disease resembling spindle tuber described by Tereschchenko in U. S. S. R.

GREY SPECK. Affects potatoes grown in peat soils in Denmark, Germnay, and Holland. Characterized by interveinal chlorosis and necrotic specks along the veins. Caused by manganese deficiency.

HAIR SPROUT. Sprout abnormality associated in different regions or years with leafroll, witches' broom, or purple-top wilt; typically occurs in the first tuber generation following plant infection with one of these viruses (q.v.), usually associated with net necrosis. Sometimes used synonymously with spindling sprout which is, however, a more general term including the production of attenuated sprouts resulting from various physiological and environmental factors.

HAYWIRE. A disease of unknown but suspected virus nature, reported from Colo., Kans., La., Nebr., Tex., and Wyo. Not transmitted by tuber grafts but transmissible by inarch grafts.

Symptoms: Plants dwarfed, rosette-like; leaflets erect, stiff, rugose, rolled, pointed, yellow or purple at tips and margins; petioles and stems with reddish or purplish discoloration and swollen at nodes; production of aerial tubers; other tubers few, small, tend to be sessile; underground stem with necrotic flecks in the pith or decayed.

Literature:

Goss, R. W. A review of the disease problems confronting the Nebraska growers of certified seed potatoes. Rept. Nebraska Potato Improv. Assoc. 1936. 1-14. 1937.

HEALTHY POTATO VIRUS. Applied in the United States to the mottle (X) virus (q.v.), latent or masked in many commercial potato vars.

HEART LEAF. See WILDING

INTERNAL BROWN SPOT. Name used chiefly in the United States for diseases of unknown but presumed physiological nature, characterized by necrotic spots in the parenchyma of tubers, usually without external manifestations and without consistent symptoms in the tops; probably equivalent to medullary necrosis.

INTERVEINAL MOSAIC. See under MOSAIC.

INTERNAL RUST SPOT. Used chiefly in England for a disease of the internal brown spot type; distinguished by the presence of necrotic blotches occurring through the parenchyma from SPRAING, which has arc-like lesions; however, this distinction is held not always to occur.

KRAUSELKRANKHEIT (G), KROESZIEKTE (H), KRÜLLENMOSAIK (G), KRUSMOSAIK (S) = CRINKLE (E), CRINKLE MOSAIC (U. S.), or a form of SEVERE MOSAIC.

KRINGERIGHEID (H), KRINGERIGHEIT (G) = CONCENTRIC NECROSIS.

LATENT VIRUS = MOTTLE (X) VIRUS (q.v.), symptomless in many commercial vars. Different strains have been described as foliar necrosis virus, potato ringspot virus, virulent latent virus, and yellow mottle virus.

LEAF CURL. Ambiguous and mostly obsolete term, originally inclusive of leafroll and equivalent to degeneration disease; now usually applied to mosaic diseases of the crinkle type.

LEAF-DROP STREAK. A virosis caused by the veinbanding (Y) virus together with (usually) the mottle (X) virus, or sometimes the effect of the former alone. See SEVERE MOSAIC VIRUS in Part I.

LEAFROLL. See LEAFROLL VIRUS in Part I.

LEAF-ROLLING MOSAIC. See LEAF-ROLLING MOSAIC VIRUS in Part I.

LEAF-TWISTING. A disease resembling spindle tuber described by Balashev in Uzbekistan (U. S. S. R.).

LEPTO-NECROSIS (LEPTONEKROSE (H)) = PHLOEM NECROSIS. Intr. by Quanjer 1931, and considered a more specific term than leafroll of which disease it is a characteristic symptom.

LITTLE LEAF. A disease of unknown cause occurring in Uzbekistan (U. S. S. R.), said to be an important factor in potato degeneration there.

MAHOGANY BROWNING. A form of low temperature injury to tubers occurring in certain vars. (Chippewa, Irish Cobbler, Katahdin, Sebago) when stored at temperatures near freezing.

MALADIE DES TÂCHES EN COURONNE (F) = CONCENTRIC NECROSIS

MARGINAL LEAFROLL. Applied by Quanjer 1921 to a form of leafroll not accompanied by phloem necrosis; used by Fernow as a synonym of "spindling tuber" though doubtful whether actually applied to the disease caused by the spindle-tuber virus. Since the latter has not been identified in Holland, marginal leafroll evidently referred to a different disease, and in the absence of proof of transmissibility its virus nature may be questioned.

Literature:

Fernow, Karl H. Spindling tuber or marginal leaf-roll. Phytopath. 13: 40. 1923

Folsom, Donald, and Reiner Bonde. List of distinct potato viroses. Amer. Potato Jour. 13: 14-16. 1936

Quanjer, H. M. New work on leaf-curl and allied diseases in Holland. Rept. Internat. Potato Conf. London 1921. 127-145. 1921

_____. General remarks on potato diseases of the curl type. Rept. Internat. Conf. Phytopath. & Econ. Ent. Holland 1923: 23-25. 1923

MEDULLARY NECROSIS. A form of internal brown spot (q.v.) associated with acid soils, possibly due to calcium deficiency.

MONOCRAAT VIRUS = TUBER BLOTCH (F) VIRUS (q.v.). So-named because latent in the Dutch var. Monocraat.

MORON DISEASE = PURPLE-TOP WILT.

MOSAIC, ANECROTIC. Originally characterized by Quanjer (1931) as potato viroses distinguished by mottling and some wrinkling of foliage but without necrosis, and including mild, interveinal, crinkle, and aucuba types of mosaic. Subsequently all except aucuba mosaic were classified in other groups.

MOSAIC, COMMON. Equivalent in Holland to simple mosaic and caused by virus A; a term not ordinarily used in the United States but sometimes applied to veinal-mosaic in commercial vars., caused by veinal mosaic

(A) virus together with latent (X) virus.

MOSAIC, CRINKLE. A form of veinal mosaic caused by the crinkle strain of veinal mosaic virus together with the mottle virus.

MOSAIC, INTERMEDIATE. A form of veinal mosaic distinguished in Holland by Quanjer, and placed by him in the acropetal necrosis group, related to or identical with Virus A.

MOSAIC, INTERVEINAL. A confused term which has been used in several different senses. As originally proposed by Quanjer it referred to a disease commonly found in the Duke of York var. in which the mottle (latent, X) virus is masked. The second virus in this var., and the one chiefly responsible for the interveinal mosaic symptoms, has been identified as the tuber-blotch (F) virus by Loughnane and Clinch. Accordingly, in England and Ireland interveinal mosaic is applied to the disease jointly induced by the mottle and tuber-blotch viruses. In 1935 Quanjer referred interveinal mosaic to his acronecrotic section as synonymous with simple mosaic as defined by Murphy. In the United States, interveinal mosaic has been applied to a virosis occurring in Irish Cobbler, American Wonder, and Russet Burbank vars. in the Northwestern States [McKay et al.]. The same disease has been called super-mild mosaic [Young & Morris]. The symptoms are similar to those described in England as induced by the mottle and tuber-blotch viruses together, but the latter virus is said not to occur here [Dykstra]. Interveinal mosaic of the Green Mountain var. is attributed to the common latent virus plus a second one called interveinal mosaic virus [Folsom & Bonde] or sometimes as a second latent virus of Green Mountain. In England the latter virus is identified as Up-to-Date streak or potato virus B, and is regarded as a strain of mottle (X) virus.

Literature:

Dykstra, T. P. A study of viruses infecting European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 40-67. 1939

_____ A study of viruses causing yellow mosaic in European and American varieties of the potato, Solanum tuberosum. Phytopath. 29: 917-933. 1939

Folsom, Donald, and Reiner Bonde. List of distinct potato viroses. Amer. Potato Jour. 13: 14-16. 1936

Loughnane, J. B., and Phyllis Clinch. Composition of interveinal mosaic of potatoes. Nature 135: 833. 1935

McKay, M. B., and T. P. Dykstra. Potato virus diseases. Oregon Agric. Exp. Sta. Bull. 294. 1-40. 1932

_____, T. P. Dykstra, H. E. Morris, P. A. Young, B. L. Richards, and H. L. Blood. Virus and viruslike diseases of the potato in the Northwest and their control. U. S. Dept. Agric. Circ. 271. 1-32. 1933

Quanjer, H. M. General remarks on potato diseases of the curl type. Internat. Conf. Phytopath. & Econ. Ent. Holland Rept. 1923: 23-25. 1923

Quanjer, H. M. Classification of potato viroses. Proc. Sixth Internat. Bot. Congr., Amsterdam, 1935, II (abstracts): 199-203. 1935.

MOSAIC, LEAFROLLING. See LEAFROLLING MOSAIC VIRUS in Part I.

MOSAIC, MILD. The more typical form of veinal mosaic in the United States and often used as equivalent to mosaic in general; more specifically it refers to the virosis caused by mild strains of veinal (A) mosaic virus (q.v.) in contrast to the crinkle strains, together with the mottle virus in most commercial varieties. Quanjer (1935) refers it to his acropetal necrosis section as related to or identical with virus A.

MOSAIC, RUGOSE. Name used in the United States for a complex virosis caused by certain strains of severe mosaic (Y) virus together with certain strains of mottle (X) virus; in general equivalent to acropetal necrosis and leaf-drop streak, the latter name gaining currency in international usage.

MOSAIC, SEVERE. A name more properly applicable to virus (Y) than to a disease, since many commercial varieties also carry the mottle (X) virus, a combination producing rugose mosaic or leaf-drop streak; also applied to the related veinbanding virus. In varieties lacking the mottle virus, these viruses alone may cause a severe mosaic disease.

MOSAIC, SIMPLE (EINFACHES MOSAIK, LEICHTESM. (G), MOSAIEKZIEKTE (H), MILD MOSAIK (S), SIMPEL MOSAIC (D). In England, and generally on continental Europe, this implies a virosis caused by mottle (X) virus (q.v. in Part I); it has also been applied [Quanjer] to mild strains of veinal mosaic (virus A) though the mottle virus also may be present.

MOSAIC, SUPER-MILD. In Holland, a virosis characterized by mottling with complete absence of leaf distortion, particularly in vars. that are tolerant of mild (veinal) mosaic; in the United States possibly identical with interveinal mosaic (q.v.).

MOSAIC, VEINAL. See VEINAL MOSAIC VIRUS in Part I.

MOTTLE. See MOTTLE (LATENT, X) VIRUS in Part I.

NET NECROSIS. A form of internal stem-end browning of tubers typically involving the phloem and extending to a depth of 12 mm or more,

occurring as a transitory symptom of leafroll, and sometimes of purple-top wilt in certain vars., especially Green Mountain.

NON-INFECTIOUS CHLOROSIS = AUCUBA MOSAIC

PAPER-LEAF. A suspected virosis of the spindle-tuber type reported in New South Wales. [Noble, R. J. Int. Bull. Plant Prot. 11: 246. 1937]

PARACRINKLE. See PARACRINKLE VIRUS in Part I.

PHLOEM NECROSIS = LEAFROLL (usually), and considered by Quanjer a more precise name. Since certain other viruses also cause phloem necrosis in potato stems, and the name leafroll has been widely adopted, the desirability of such a change is questionable.

PRESIDENT STREAK. A virus of the mottle (X) group, latent in the President var., also known as foliar necrosis virus, potato virus D, and Solanum virus 6.

PROPFENBILDUNG (G) = CONCENTRIC NECROSIS.

PSEUDO-NET NECROSIS = TUBER-BLOTCH VIRUS

PSYLLID YELLOWS. A disease of imperfectly known etiology, so named by Richards (1931).

Geographical distribution: United States (Ariz., Calif., Colo., Idaho, Mont., Nebr., N. Mex., S. Dak., Tex., Utah, Wyo.); Canada (Alta., Sask.).

Suscepts:

SOLANACEAE --*Solanum tuberosum L., all tested vars. including Bliss Triumph, Chippewa, Early Ohio, Irish Cobbler, Katahdin, Red McClure, Russet Burbank, and Warba; also *tomato (Lycopersicon esculentum Mill.)

Other cultivated plants of this family as peppers (Capsicum frutescens L.), eggplant (Solanum melongena L.), and Jerusalem-cherry (S. pseudo-capsicum L.) have been experimentally infected by confinement in cages with ? viruliferous insects [Binkley]. Other Solanaceae, including endemic species as Physalis longifolia Nutt., and cultivated plants and weeds as Datura, tobacco, Solanum capsicastrum Link, S. nigrum L., and Lycium halimifolium Mill., are favorable food plants for the tomato psyllid but have not been reported as showing symptoms of psyllid yellows [Richards & Blood].

Symptoms: Marginal yellowing and upward rolling or cupping of basal portion of small leaflets of young leaves, erect position of leaflets over midrib, reddish or purplish discoloration, eventually rolling of larger leaflets, systemic necrotic spotting, yellowing, general necrosis; proliferation of axial buds with formation of aerial tubers or rosettes of small, malformed leaves; hypertrophy of stem apex; suppression of stolon growth and tuber-formation when young plants are affected or stimulation of stolon production in older plants; tubers replaced by sprouts, or formed numerously and sprouting without a rest period. Under low light intensity, the basal leaflets of young leaves turn yellow, become linear, and exhibit a general interveinal chlorosis or xanthosis [Richards & Blood]. Causes phloem necrosis in stems and tubers, and net necrosis in tubers. [Sanford & Grimble].

Etiological relations: The disease is exclusively induced by the feeding of the nymphal stages of the tomato psyllid, Paratrioza cockerelli (Sulc.), but it is not limited to the feeding site, i. e. it appears to be systemic; adult insects are unable to produce the disease, and and nymphs reared from eggs produced on disease-free plants cause the symptoms to appear in potatoes as readily as those obtained from affected plants. The expression of symptoms is conditional upon continued feeding of the insect, and recovery sets in when feeding is interrrupted. As few as 3 to 5 nymphs per plant may induce symptoms under favorable conditions, but ordinarily 15 to 30 are required. A minimum feeding period of 3 to 4 days is necessary to produce definite symptoms. The disease is not perpetuated in tubers, and cannot be communicated to healthy plants by juice transfer or grafting [Richards & Bood] although claims of tuber perpetuation have been made.

Literature:

Binkley, M. A. Transmission studies with the new psyllid yellows disease of Solanaceous plants. Proc. Amer. Soc. Hort. Soc. 26: 249-254. 1930

Richards, B. L., and H. L. Blood. Psyllid yellows of the potato. Jour. Agric. Res. 46: 189-216. 1933

_____, _____, and M. B. Linford. Destructive outbreak of unknown potato disease in Utah. U. S. Dept. Agric. Plant Dis. Rptr. 11: 93-94. 1927

Sanford, G. B., and J. G. Grimble. Observations on phloem necrosis of potato tubers. Canad. Jour. Res. 22 C: 162-170. 1944

Shapovalov, M. Tuber transmission of psyllid yellows in California. Phytopath. 19: 1140. 1929

PUNCTATE NECROSIS. Strain of mottle (X) virus found in the Chippewa var. in Wisconsin, differing from latent virus in causing a foliar mottle and necrotic flecking in this and other vars.

PURPLE-TOP WILT (PURPLE TOP, ? PURPLE DWARF). Usually applied to a disease induced in potatoes by aster yellows virus, specifically the

Eastern or New York strain (q.v. in Part I). It is uncertain whether all the disease examples thus named are specifically due to this virus.

RAUHMOSAIK (G) = KRÄUSELKRANKHEIT (G) = CRINKLE (E)

RINGSPOT, POTATO. Strain of mottle (latent, X) virus causing a ringspot disease in tobacco distinct from ordinary tobacco ringspot.

RUST(Y) SPOT. Probably identical with medullary necrosis, a nutritional disorder. See also INTERNAL RUST SPOT.

RYNKESYGE (D) = RUGOSE MOSAIC (U.S.).

SPINACH LEAF. See WILDING

SPINDLE TUBER. See SPINDLE TUBER VIRUS in Part I.

SPINDLING SPROUT. Attenuation of sprouts associated with certain viroses as leafroll, especially when net necrosis also is present, purple-top wilt, and witches'-broom; also resulting from conditions obtaining during growth or storage of tubers in the absence of virus infection.

SPINDLING TUBER. Obsolete name for SPINDLE TUBER.

SPOT NECROSIS. A strain of latent (X) virus of potatoes causing foliar necrotic spotting when inoculated to tobacco.

SPRAING. A form of concentric necrosis (q.v.) characterized by internal, arc-like, necrotic lesions near the surface of tubers; thought to be contracted from the soil and transmissible by tuber grafts; bacterial etiology now discredited.

STEM-END BROWNING. Non-parasitic internal discoloration of tubers, shallow (usually less than 12 mm), involving both xylem and phloem; usually attributed to nutritional and moisture conditions; not tuber-perpetuated.

STIPPLE-STREAK (STIPPELSTREEPZIEKTE (H), STRICHELKRANKHEIT, probably also SCHWARZFLECKEN and STREIFENKRANKHEIT (G), STREGSYGE (D), STRIMSJUKA

(S). Virosis caused by a strain of severe mosaic (Y) virus (q.v. in Part I).

STREAK. As originally applied by Orton (1914) this referred to the occurrence of elongated, angular, necrotic spots following the veins and invading the parenchyma in the upper, full-grown leaves of certain potato vars., chiefly seedlings and foreign vars. that were grown in Maine. Further development of the disease involved extensive stem-streaking, leaf-dropping, and ultimately death of shoots or entire plants -- features characteristic of acronecrosis (mottle or X virus), in intolerant vars. Some of these effects also suggest the presence of Y virus. Schultz & Folsom (1922, 1923) used this name for a necrotic spot disease of the Green Mountain and other vars. which has not been further identified but is believed not to have resulted from either the X or Y viruses, and at any rate was distinct from leaf-drop streak, a phase of rugose or severe mosaic. See LEAF-DROP STREAK, DI VERNON STREAK, PRESIDENT STREAK, UP-TO-DATE STREAK, and FOLIAR NECROSIS above.

TOP NECROSIS (ACRONECROSIS). For specific types see PRESIDENT and UP-TO-DATE STREAKS, FOLIAR NECROSIS and AUCKLANDER SHORT-TOP

TUBER BLOTCH. See TUBER BLOTCH VIRUS in Part I.

UNMOTTLED CURLY DWARF. A virosis of the spindle tuber type with intensified symptoms. See UNMOTTLED CURLY DWARF VIRUS in Part I.

UP-TO-DATE STREAK. A virus of the mottle (X) group latent in this var.; also known as potato virus B and Solanum virus 4.

VEINBANDING. A virus of the severe mosaic (Y) group (q.v.) so named because it causes veinbanding (veinal chlorosis) in tobacco.

VIRA-CABEÇA (twisted head). Name applied in Brasil to tomato spotted wilt, or to the virus, especially to this disease in tobacco, sometimes to its effects in potato.

VIRULENT LATENT VIRUS. See under LATENT VIRUS.

WILDING. A term used in Britain and Australia, not ordinarily in the United States; probably synonymous in the main with WITCHES'-BROOM, since this disease was regarded by P. A. Murphy as similar to the condition called "wildings" in England and Scotland. The tendency of leaves of plants infected with witches'-broom (q.v.) to become simple

and cordate has led to the use of the descriptive terms heart-leaf and spinach leaf in connection with this disease, but leaves of this pattern also occur as genetic variations. Some examples of wilding are also of this nature.

WITCHES'-BROOM. See WITCHES'-BROOM VIRUS in Part I.

YELLOW DWARF. See YELLOW-DWARF VIRUS in Part I.

YELLOW MOTTLE. A strain of mottle (X) virus (q.v.) characterized by a yellow mottle in contrast to the ordinary green mottle.

YELLOW TOP. Incompletely known, possibly heterogeneous virosis. In Maine it has been considered in part synonymous with APICAL LEAFROLL and in part with WITCHES'-BROOM (q.v.), and also as possibly due to aster yellows virus. In Montana it may have been applied to one aspect of witches'-broom or possibly of psyllid yellows.